Experimental interplay between the top quark and Supersymmetry at the LHC and Tevatron

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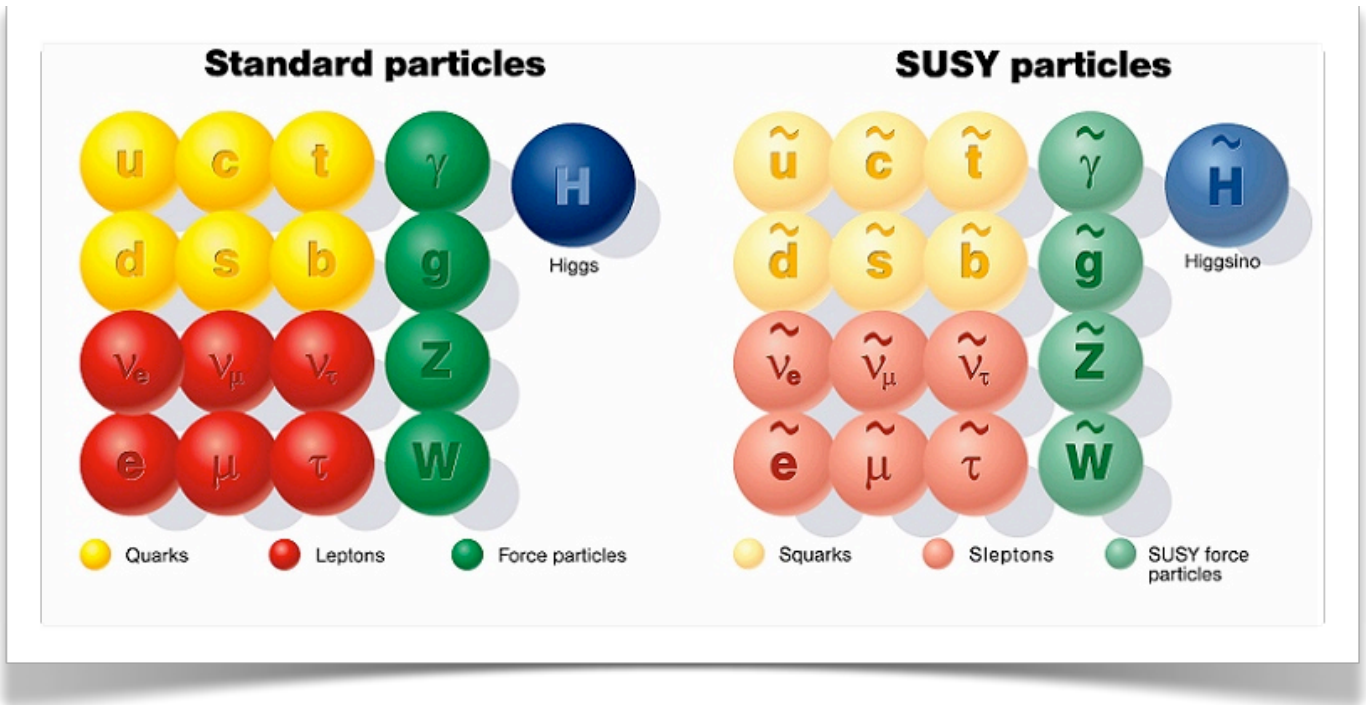
Outline

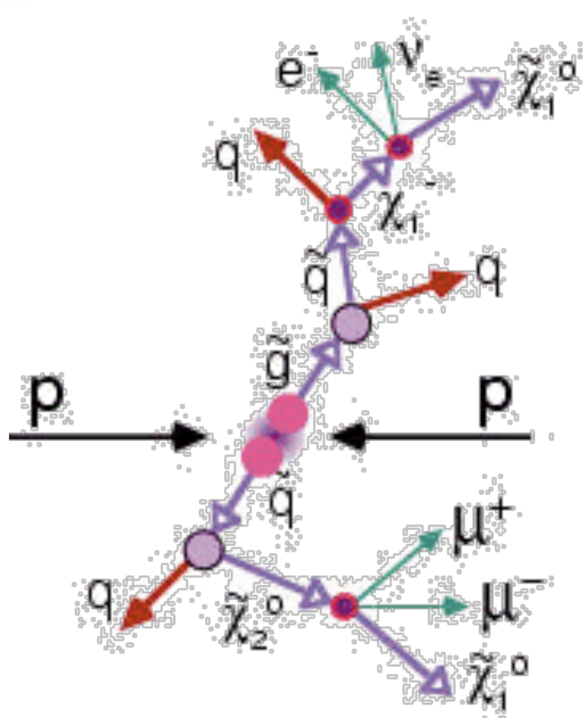
- SUSY: why and how will it look like?
- Top as a (dominant) background to SUSY
- Searches for the scalar top partner
- Outlook

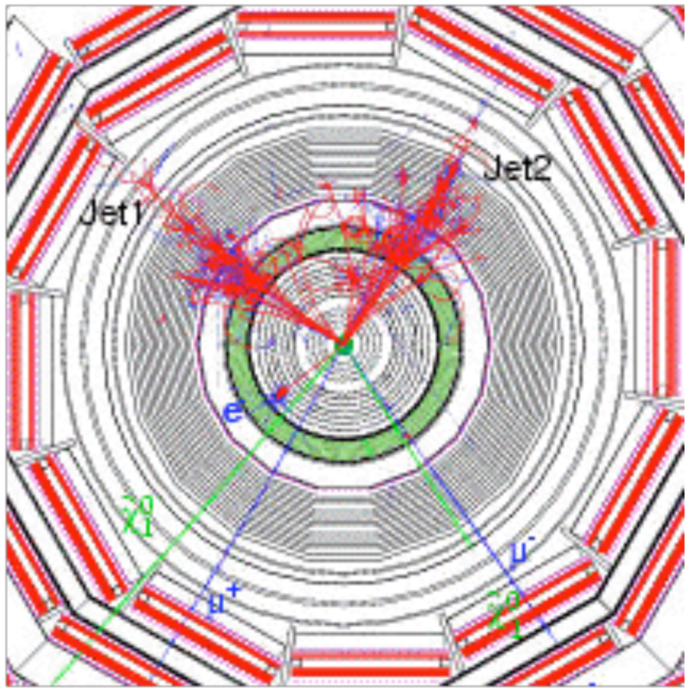
Disclaimer: the emphasis of the talk will be on LHC results

Why SUSY, and how will it look like?

- **Supersymmetry: often considered favorite SM extension**
  - Provides good dark matter candidate
  - Coupling constant unification
  - **Solution to fine-tuning problem of the Higgs → need SUSY to be at the O(TeV) scale**
- **<u>Generic SUSY pheno</u>**:
  - **Strongly interacting** particle production typically dominates (squark, gluinos)
  - Long decay chains: lots of **high-p_T jets, leptons, etc**
  - LSP is stable (R-parity conserving) → **large E_T^{miss}**







You said signature of (b)-jets, real E_T^{miss}, lepton(s)?

Some **examples** of generic SUSY searches →

- **Top almost always #1 background!**
- ttbar estimation is analysis-dependent but always has data-driven component
- General idea is to use top-enriched CR with cuts as close to SR but with little signal contamination, for example:
  - CR with additional leptons wrt signal: lost e/μ or τ^{had} often dominates
  - Lower H_T, transverse mass or E_T^{miss} CR
- Then extrapolate to signal region(s), e.g.:
  - MC/data transfer factor
  - Using pure data info (e.g. lepton eff.)

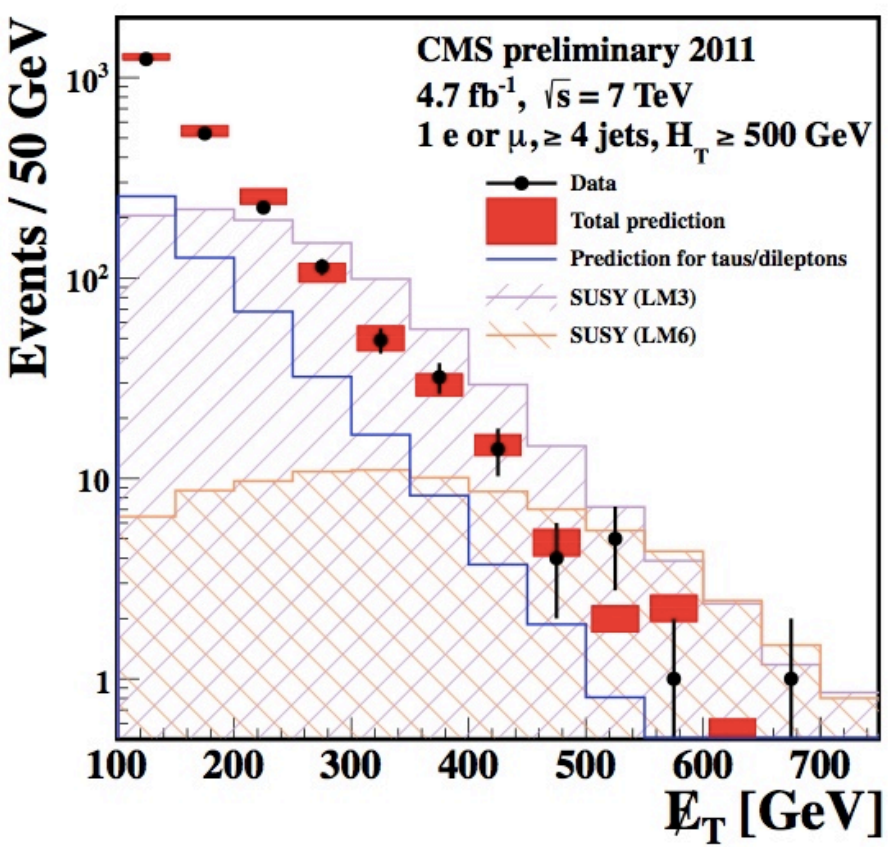
Ref.	Exp.	# of lep.	b-jets?	**Rank of ttbar**	Ttbar uncert.
PAS-SUS-12-016	CMS (8 TeV)	0	n	**#1-3(1)**	10-70%
PAS-SUS-12-016	CMS (8 TeV)	0	y	**#1(1)**	8-70%
PAS-SUS-12-010	CMS (7 TeV)	1	n	**#1**	17-200%
PAS-SUS-12-017	CMS (8 TeV)	2 (SS)	y	**#1(2)**	52-167%
1206.3949	CMS (7 TeV)	2 (OS)	n	**#1**	57-63%
ATLAS-CONF-2012-109	ATLAS (8 TeV)	0	n	**#1-3**	24-70%
1203.6193	ATLAS (7 TeV)	0	y	**#1**	16-35%
ATLAS-CONF-2012-104	ATLAS (8 TeV)	1	n	**#1-2**	37-73%
ATLAS-CONF-2012-105	ATLAS (8 TeV)	2 (SS)	n	**#2(2)**	40%
1208.4688	ATLAS (7 TeV)	2 (OS)	n	**#1**	33-100%

(1) Estimated together with W+jets background
(2) ttbar+W and ttbar+Z

Two examples of top background estimate (inclusive searches)

CMS: lepton p_T spectrum method

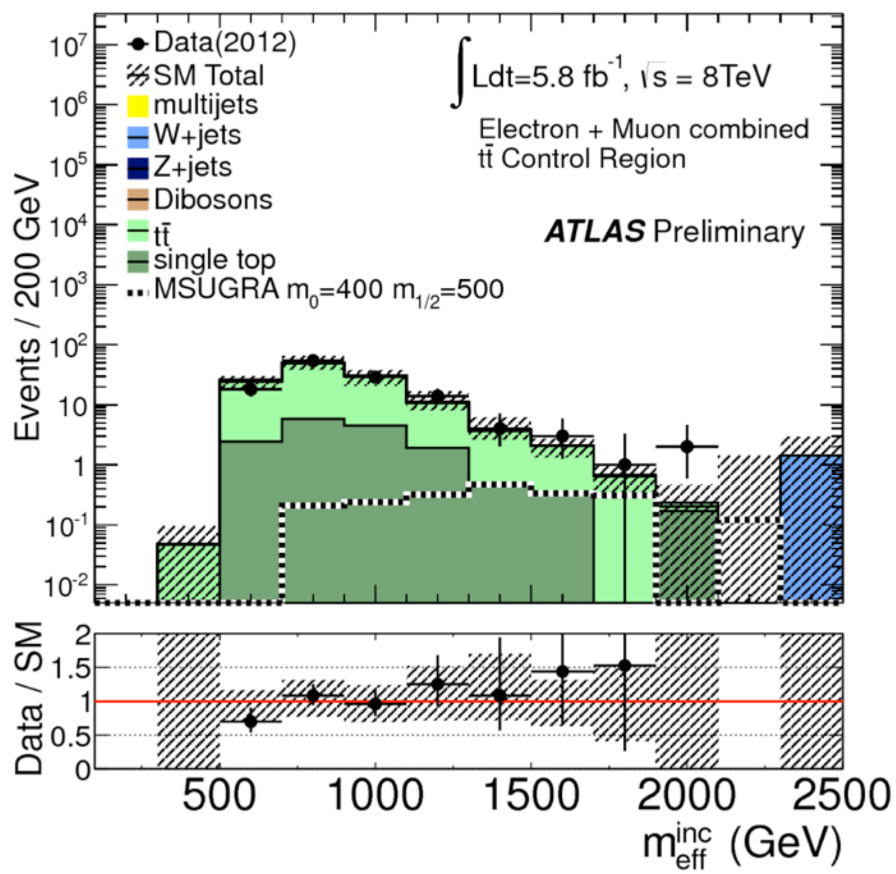
- Premise: p_T of lepton from W decay is anti-correlated to neutrino
- Raw prediction corrected for: (1) W polarization, (2) lepton p_T threshold, (3) different lepton vs E_T^{miss} resol.
- Similar method $p_T(\ell\ell)$ for 2-ℓ OS channel



ATLAS: transfer factors

$$N_{\rm SR} = \frac{N_{\rm SR}^{\rm MC}}{N_{\rm CR}^{\rm MC}}(N_{\rm CR}^{\rm obs} - N_{\rm CR}^{\rm res}) = T_f(N_{\rm CR}^{\rm obs} - N_{\rm CR}^{\rm res})$$

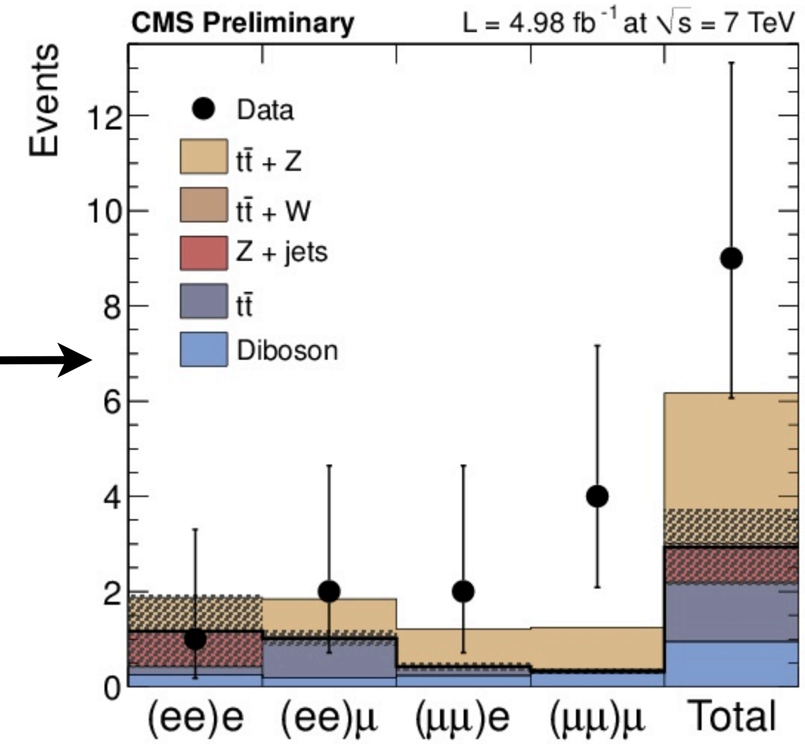
- Define **control regions** that are (1) pure (e.g. signal-free) and (2) kinematically close to SR
- Extrapolation **transfer factor** from MC
  - MC systematics largely cancel out
- Fit CR and SR simultaneously



TtbarV as a background to SUSY

- TtbarW and ttbarZ have very **small cross-sections**. NLO predictions:
    - ttbarW: $0.17^{+0.03}_{-0.05}$ pb, ttbarZ: 0.14 pb
- **But becoming more important** as SUSY is still escaping detection and ttbarV can produce
    - Additional leptons (SS or trilepton)
    - More E_T^{miss} from W/Z→**νl/νν**
- **Large background in SUSY SS dilepton** searches (dominant with b-tagging)
- CMS observes evidence of ttbarV (4.67σ) and ttbarZ (3.66σ)
- ATLAS also searched for it (no evidence yet)

CMS ttbarZ

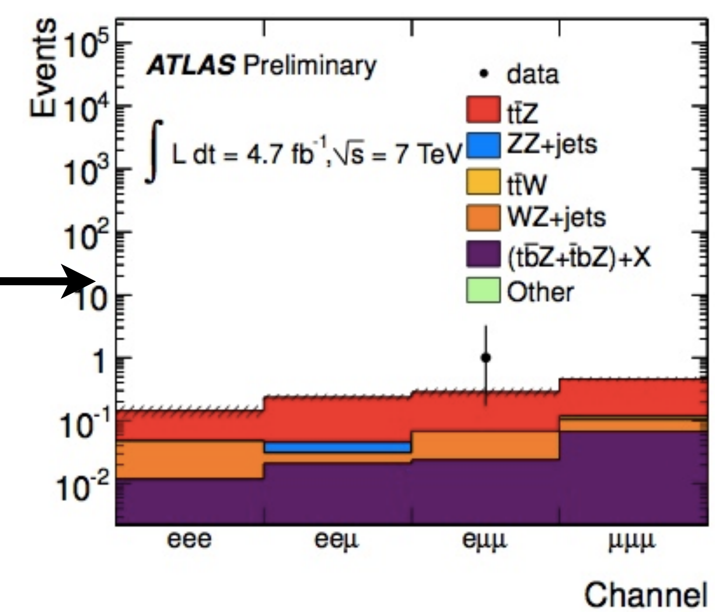


$$\sigma_{ttZ} = 0.30 \; {}^{+0.14}_{-0.11} \; (\text{stat}) \; {}^{+0.04}_{-0.02} \; (\text{syst}) \; \text{pb}$$

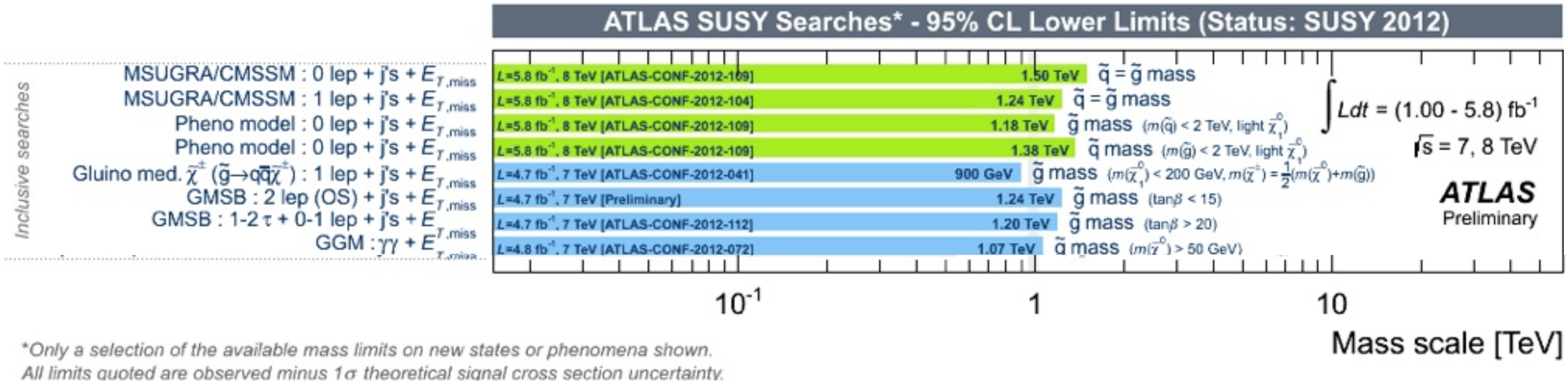
$$\sigma_{ttV} = 0.51 \; {}^{+0.15}_{-0.13} \; (\text{stat}) \; {}^{+0.05}_{-0.04} \; (\text{syst}) \; \text{pb}$$

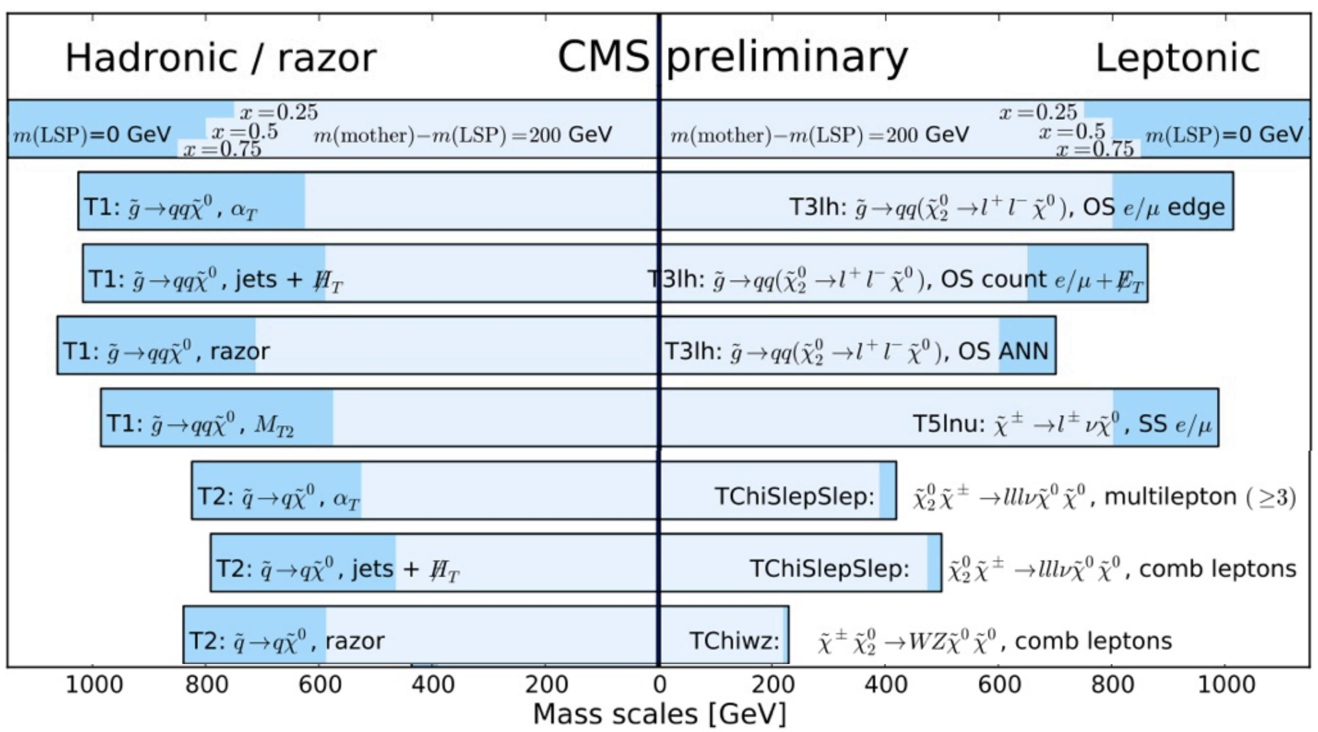
ATLAS ttbarZ

σ<0.71 pb at 95%CL



Unfortunately no signs yet of SUSY in inclusive searches!

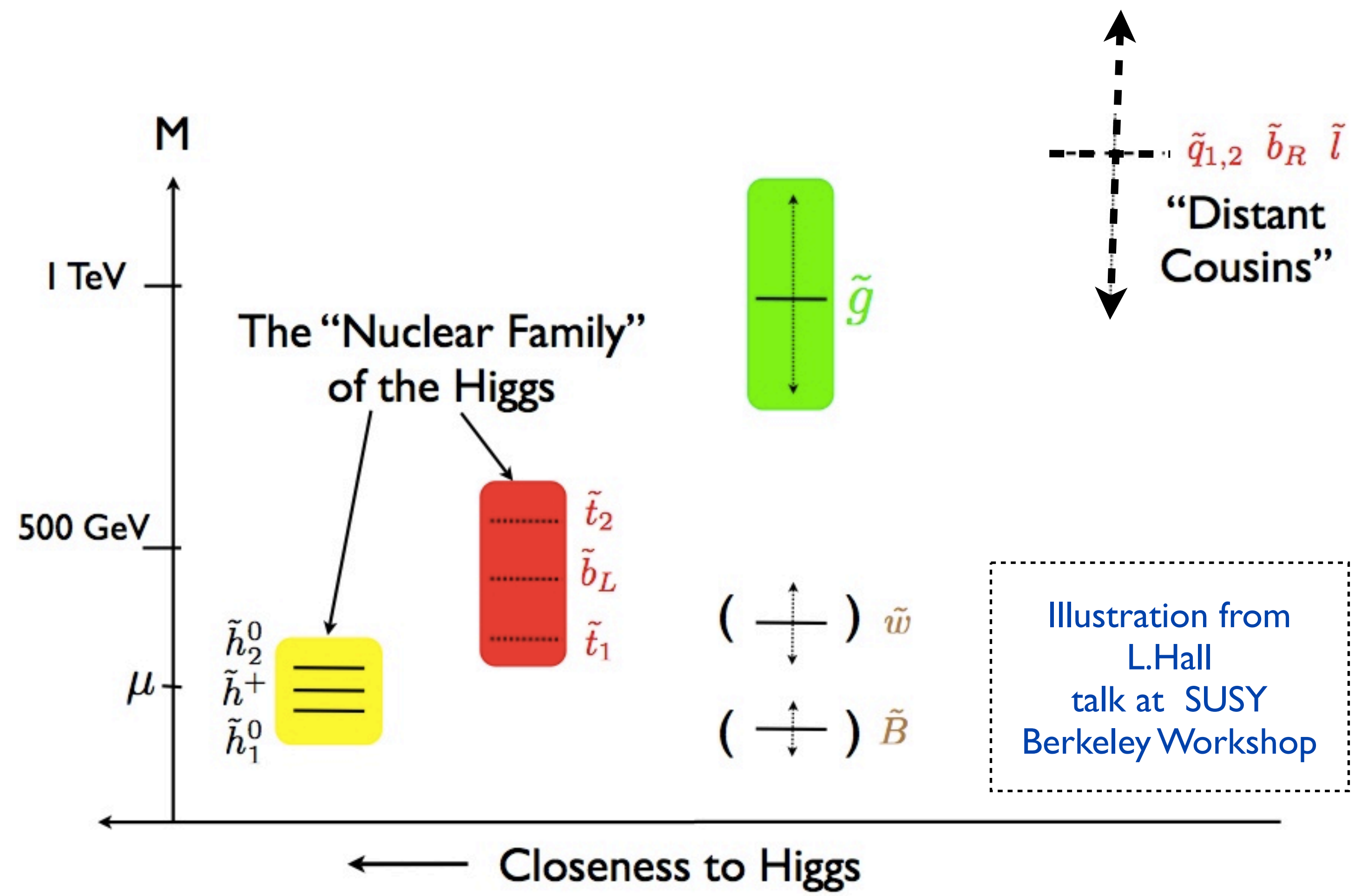




→Move to more specific signatures

Natural SUSY → light 3rd generation squarks!

- **Solution to fine-tuning** of the Higgs is the **most important motivation** for SUSY to be **discoverable at the LHC**
- **Stop (and sbottom) must be light** to cancel large top corrections to Higgs mass (fine-tuning) → **natural SUSY**
    - Appear at the 1-loop level in Higgs mass correction term
    - Stop and left-handed sbottom ≲500-1000 GeV (level of fine-tuning is somewhat arbitrary)
    - Gluino must also be relatively light (2-loop level)



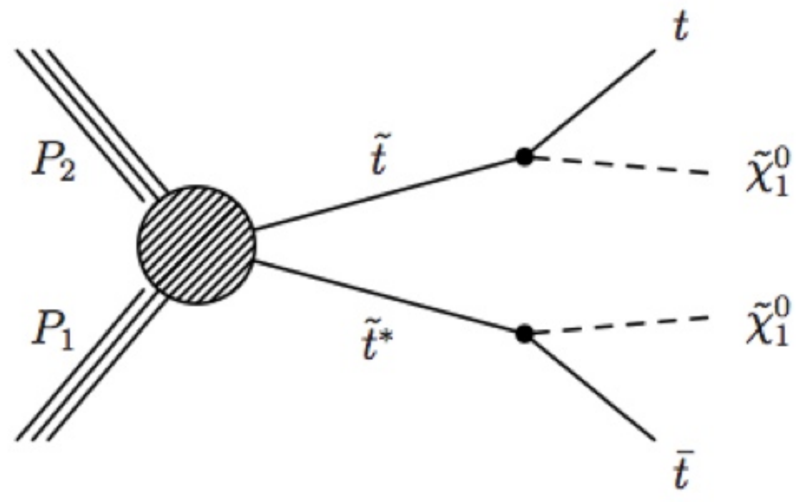
Dedicated searches are needed!

- Limits for inclusive searches are necessarily very stringent on 3rd generation
- Stop (and sbottom) **decay to top quarks** for several model parameters

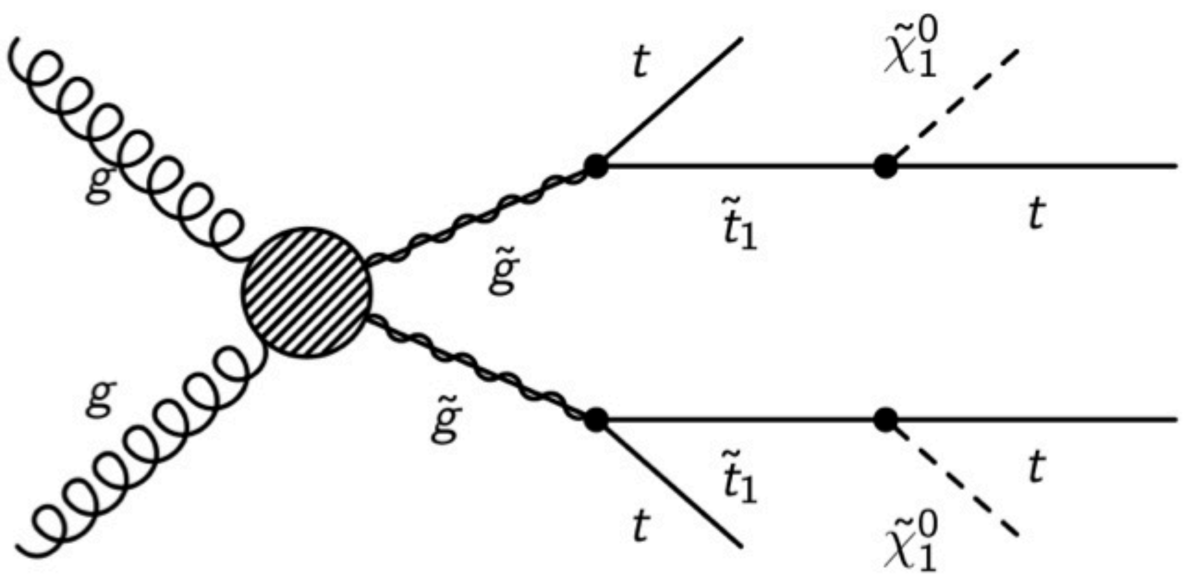
3rd generation signatures

- **Two production modes:**
  - Gluino-mediated
  - Direct production
- I will concentrate on final states containing top quarks (since we're at TOP'12!)

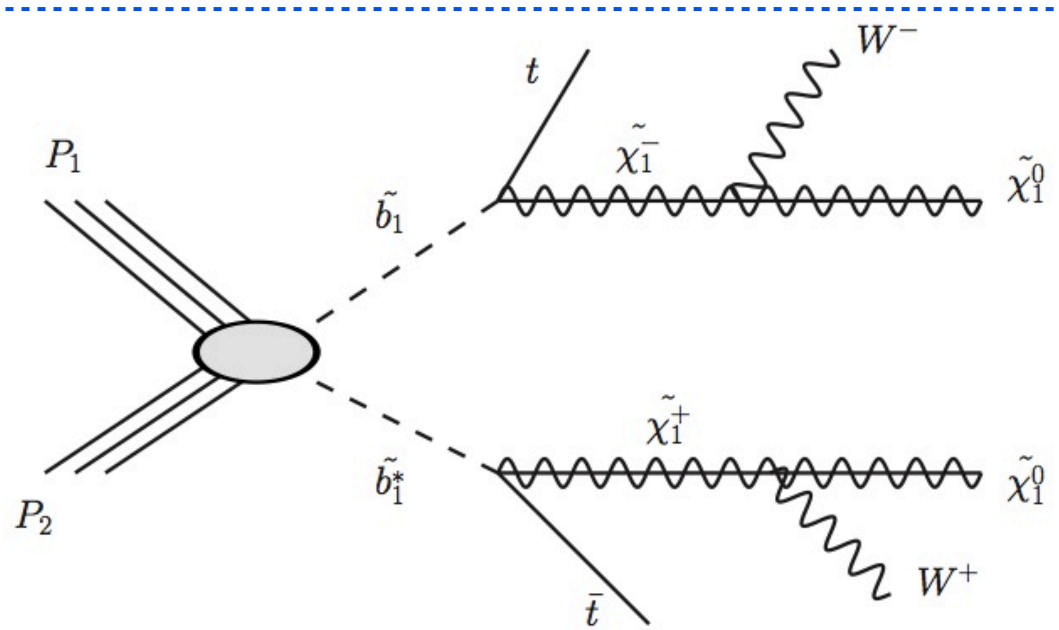
Direct stop → ttbar + E_T^{miss}



Gluino-mediated stop → 4 top + E_T^{miss}

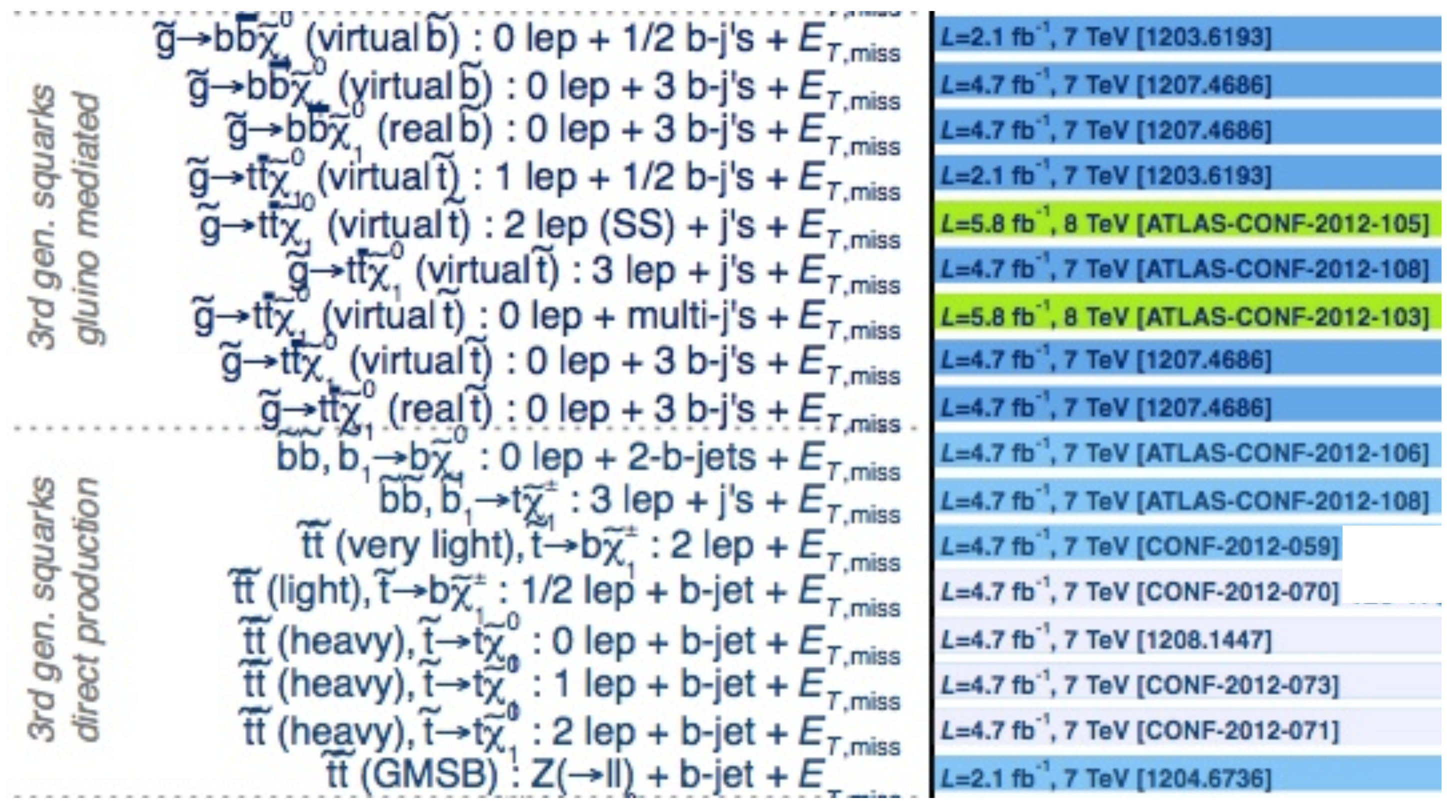


Direct sbottom → ttbar + W^+W^- + E_T^{miss}



Already lots of dedicated 3rd generation squarks searches at LHC!!

ATLAS

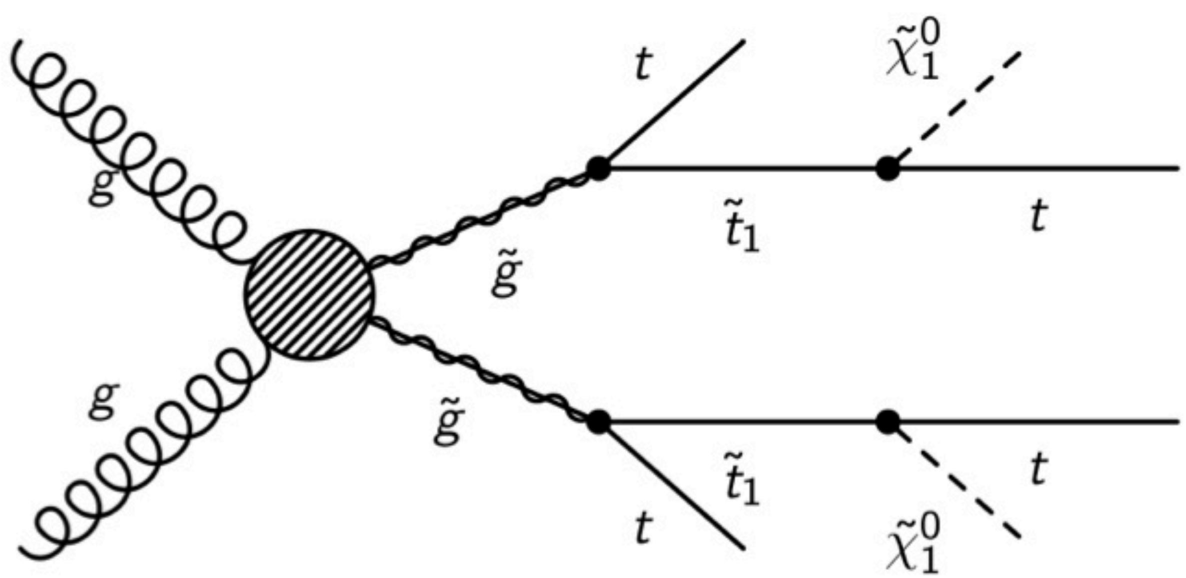


CMS

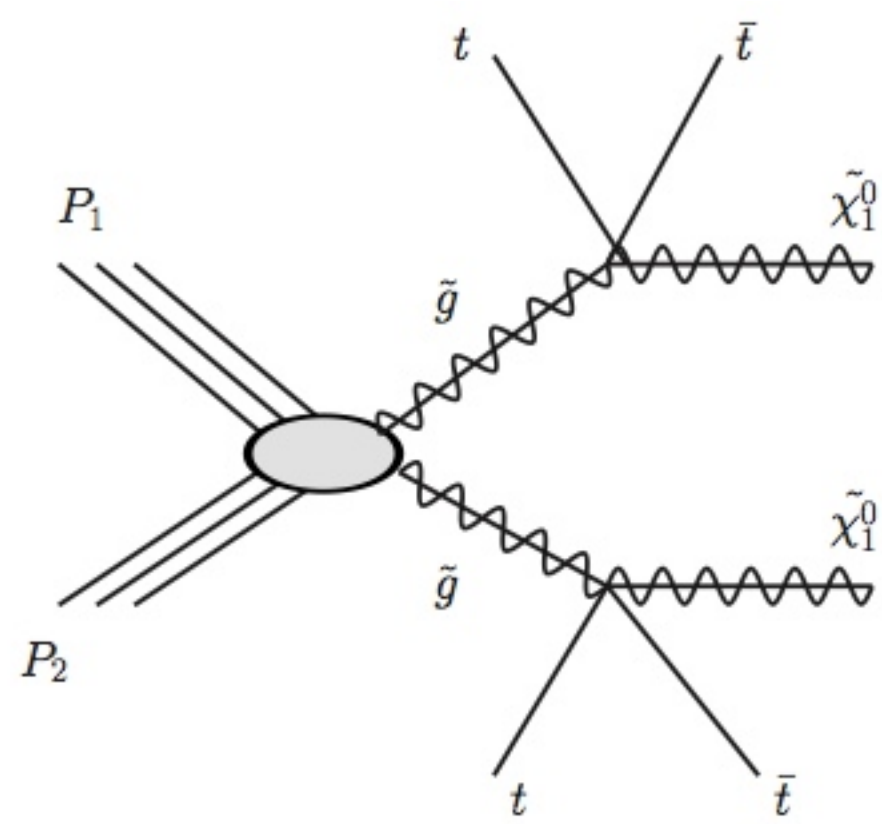
Signature	$\sqrt{s}$ [TeV]	Latest Lumi [fb^{-1}]	Reference
Jets+E_T^{miss} + b-jets	7	4.98	SUS−12−003
α_T + b-jets	8	3.9	SUS−11−022, SUS−12−016
M_{T2} + b-jets	7	4.73	arXiv:1207.1798
Razor	7	4.4-4.98	SUS−11−024, SUS−12−005, SUS−12−009
2 ℓ (SS) + b-jets	8	3.95	arXiv:1205.3933, SUS−12−017
1 ℓ +E_T^{miss} (sign) + b-jets	7	4.98	SUS−11−028
1 ℓ +E_T^{miss} + b-jets	7	4.96	SUS−11−027

Gluino-mediated production

"Natural" gluino-mediated stop production:



Gtt (T1tttt) simplified model (off-shell stop):

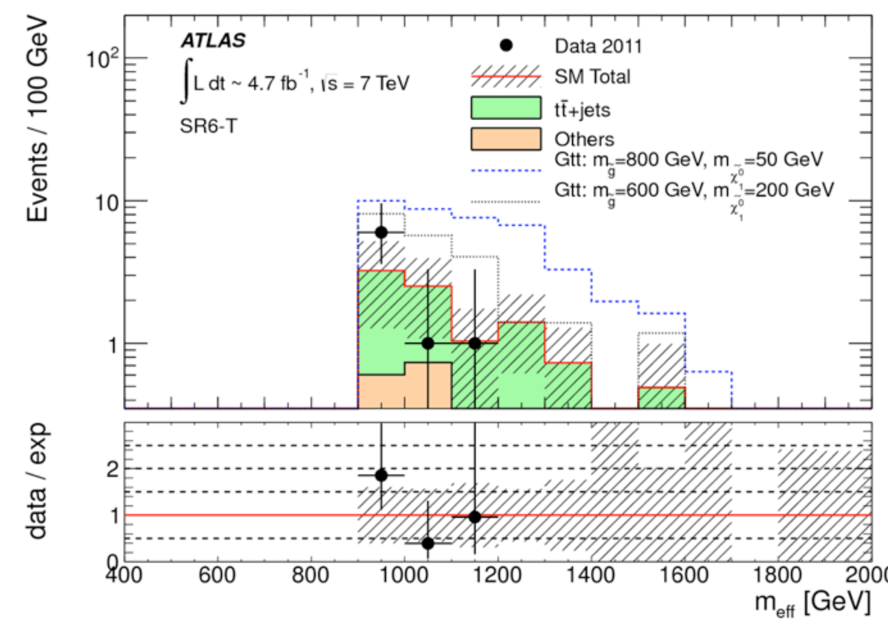


ATLAS 0 ℓ + 3 **b-**jets + E_T^{miss} (7 TeV)

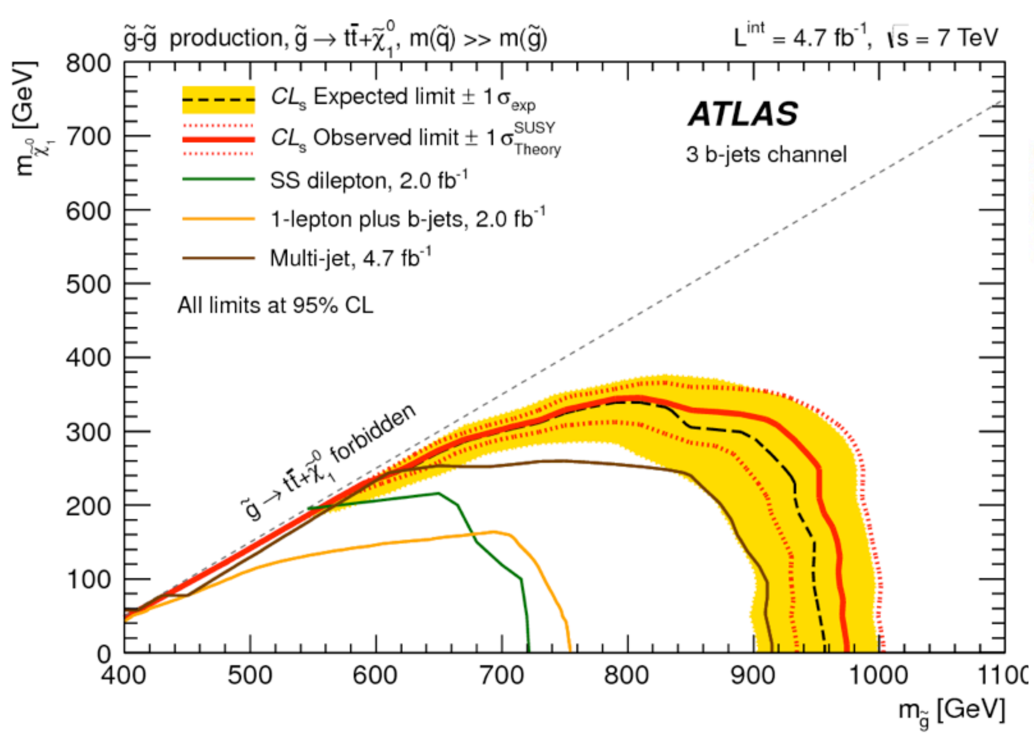
Veto e/μ, require jet p_T>50 GeV, leading jet p_T>130 GeV
Define 5 signal region:

SR	N_J	E_T^{miss}	m_{eff}	b-tag OP
SR4-L	$\geq$ 4j	>160 GeV	>500 GeV	60%
SR4-M	$\geq$ 4j	>160 GeV	>700 GeV	60%
SR4-T	$\geq$ 4j	>160 GeV	>900 GeV	70%
SR6-L	$\geq$ 6j	>160 GeV	>700 GeV	70%
SR6-T	$\geq$ 6j	>200 GeV	>900 GeV	75%

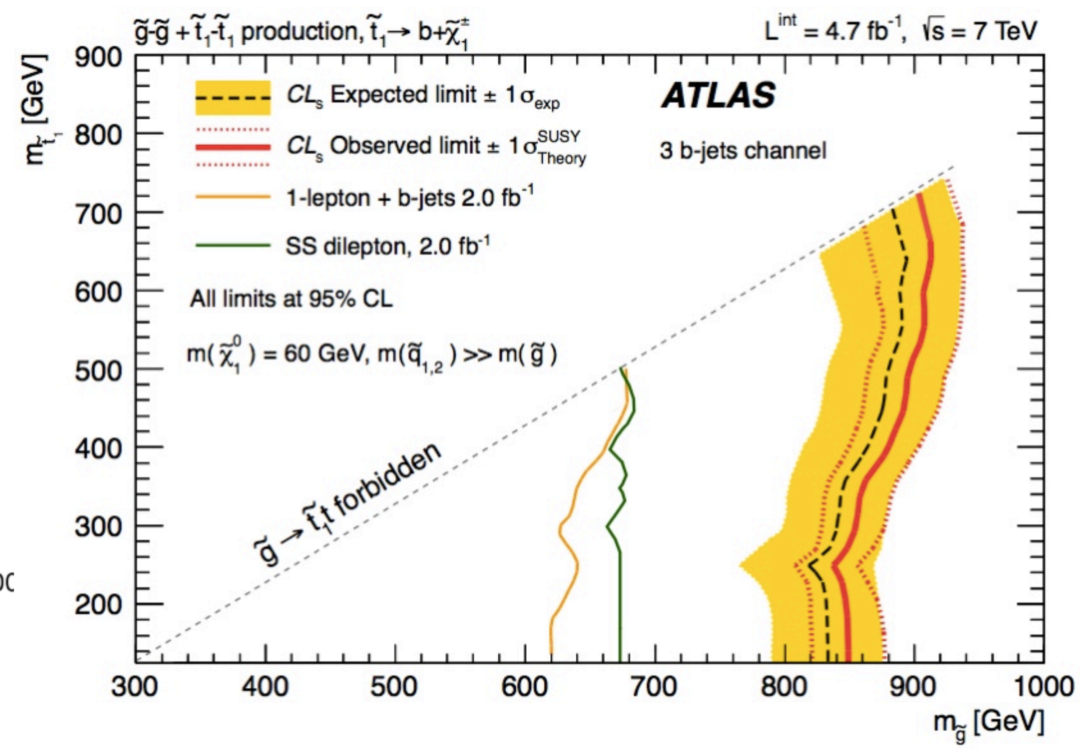
M_{eff} for tightest SR



Limits obtained in simplified "Gtt" model:
gluino up-to 0.94 TeV (neutralino up-to 300 GeV)



Limits in the case of real stop



arXiv 1207.4686

CMS α_T 0 ℓ +(b-)jets (8 TeV)

<u>Event selections:</u>

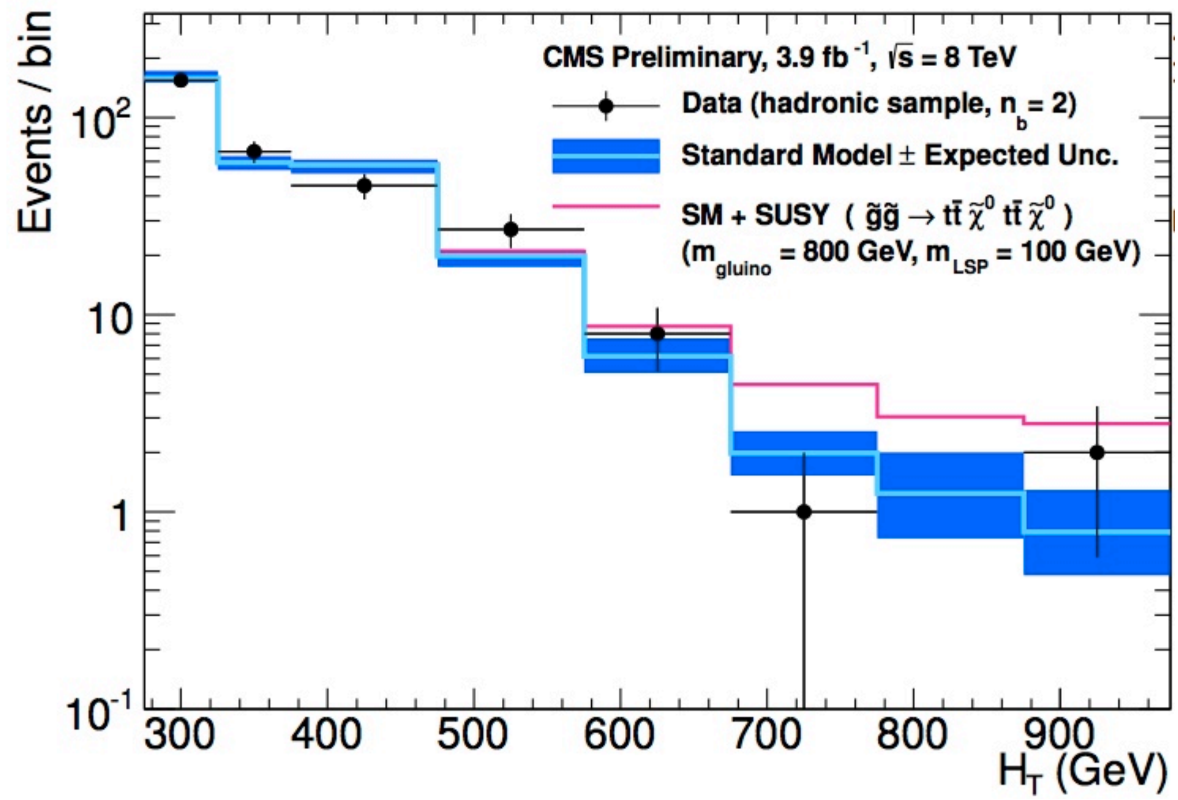
- $\geq$2 jets p_T>100 GeV
- Isolated lepton veto
- H_T>275 GeV, α_T>0.55

(*α_T discriminates real vs fake E_T^{miss}*)

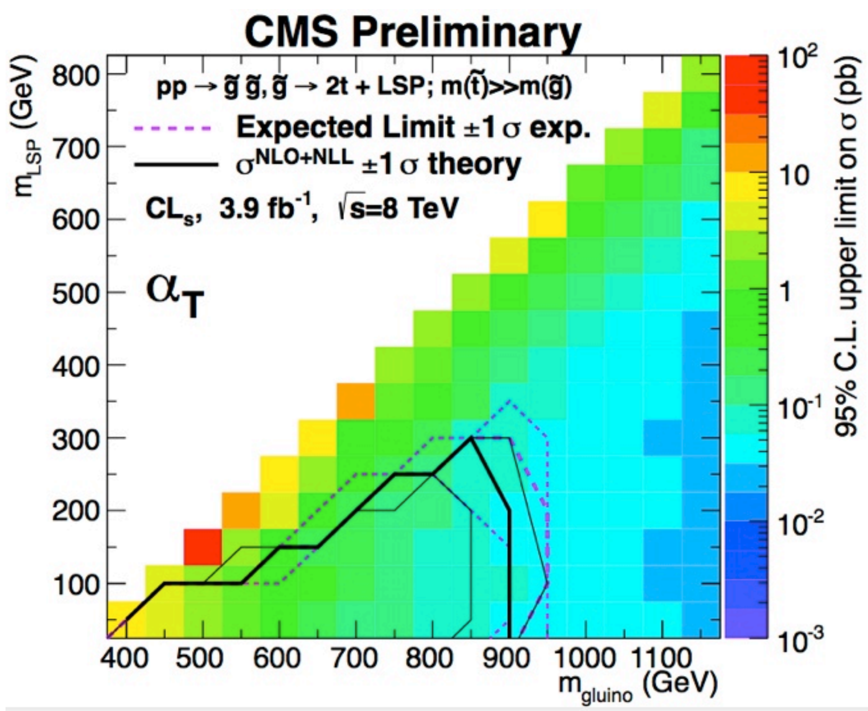
- Define several SR based on H_T cut (>275-875 GeV) and number of b-tags ($\geq$0-3)
- Bkgd estimated through TF

(*Top dominates for $\geq$1b-tag*)

Event yield vs H_T for 1 b-tag events



Limits obtained in simplified "Gtt" model **gluino ≲ 0.85 TeV (LSP ≲ 250 GeV)**



SUS-12-016

CMS has several other 0-lepton analyses interpreted in gluino-mediated stop production:

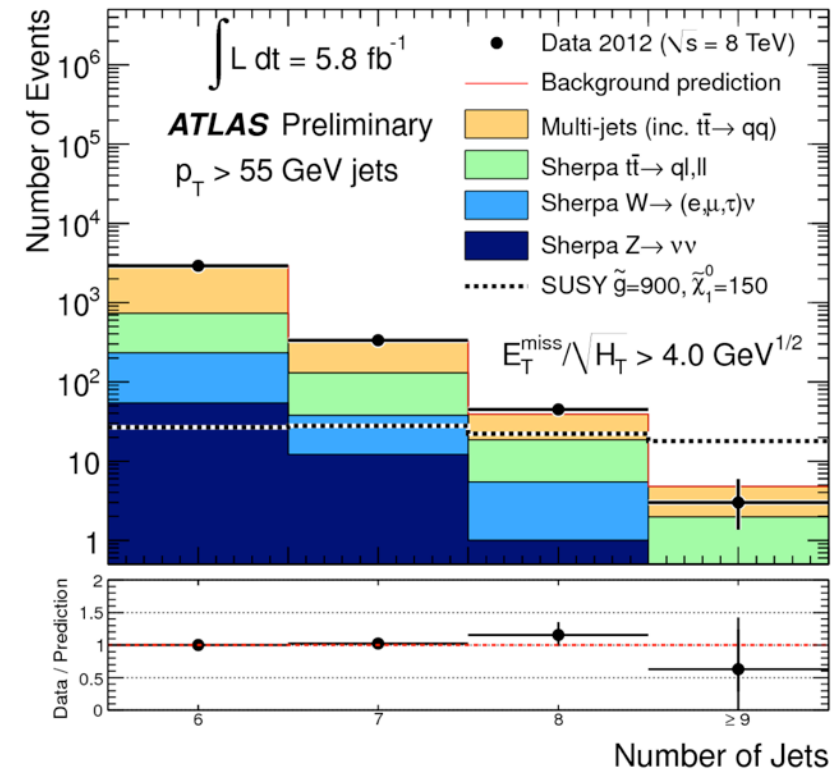
- Razor analyses (7 TeV): SUS-11-024, SUS-12-005, SUS-12-009
- M_{T2} with b-jets (7 TeV): SUS-12-002
- b-jets+Met (7 TeV): SUS-12-003

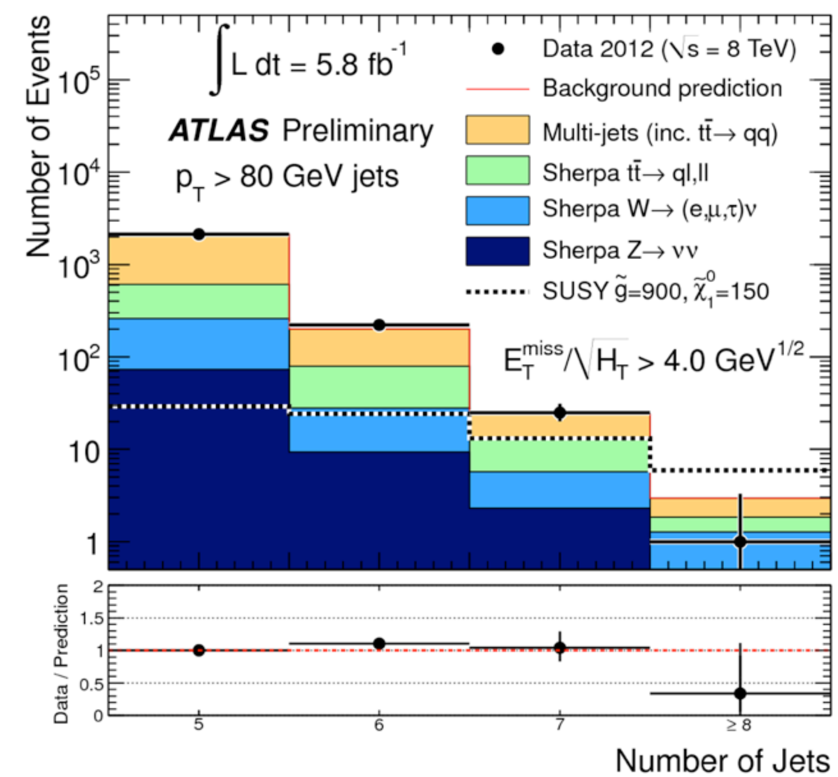
ATLAS 0 ℓ + multi-jets + E_T^{miss} (8 TeV)

Event selections:

Signal region	7j55	8j55	9j55	6j80	7j80	8j80
Number of isolated leptons (e, μ)	= 0					
Jet p_T	> 55 GeV			> 80 GeV		
Jet $\lvert\eta\rvert$	< 2.8					
Number of jets	≥ 7	≥ 8	≥ 9	≥ 6	≥ 7	≥ 8
$E_T^{miss} / \sqrt{H_T}$	> 4 GeV$^{1/2}$					

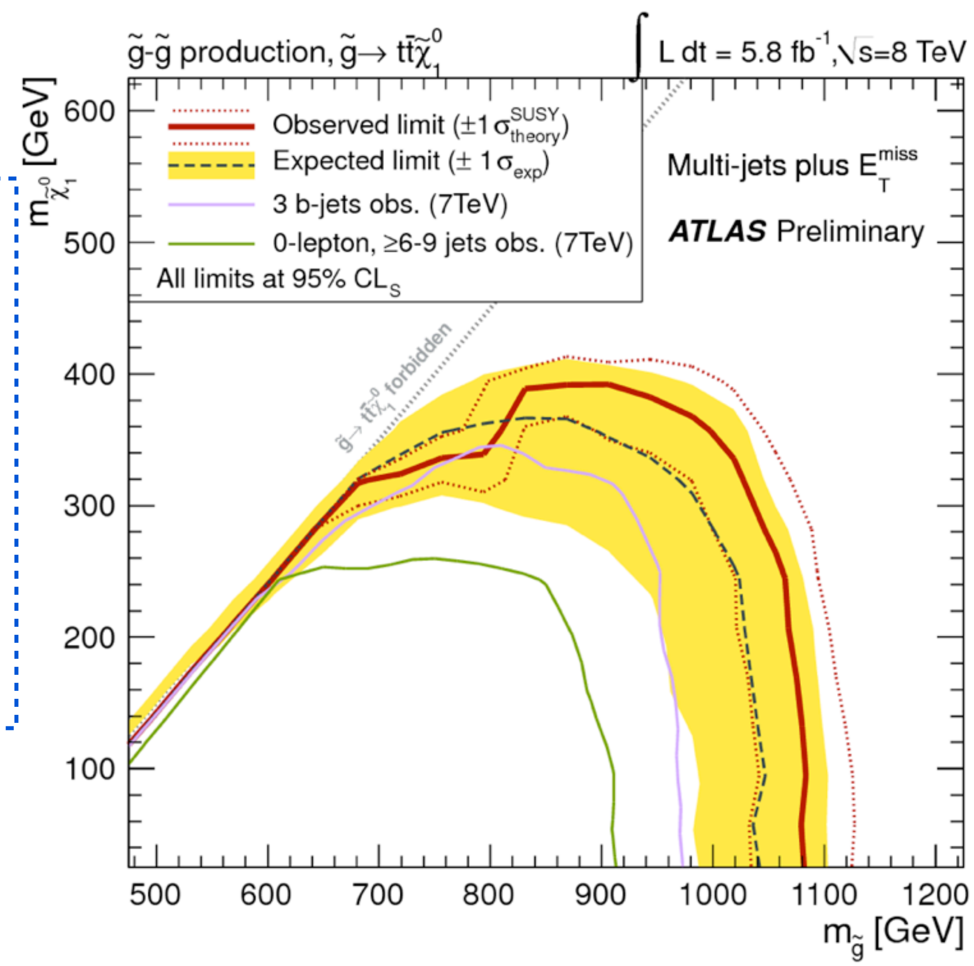
Event yield vs njets





Limits obtained in simplified "Gtt" model

gluino up-to 1.0 TeV (neutralino up-to 360 GeV)



ATLAS-CONF-2012-103

CMS 1 ℓ + **b-**jets + E_T^{miss} (7 TeV)

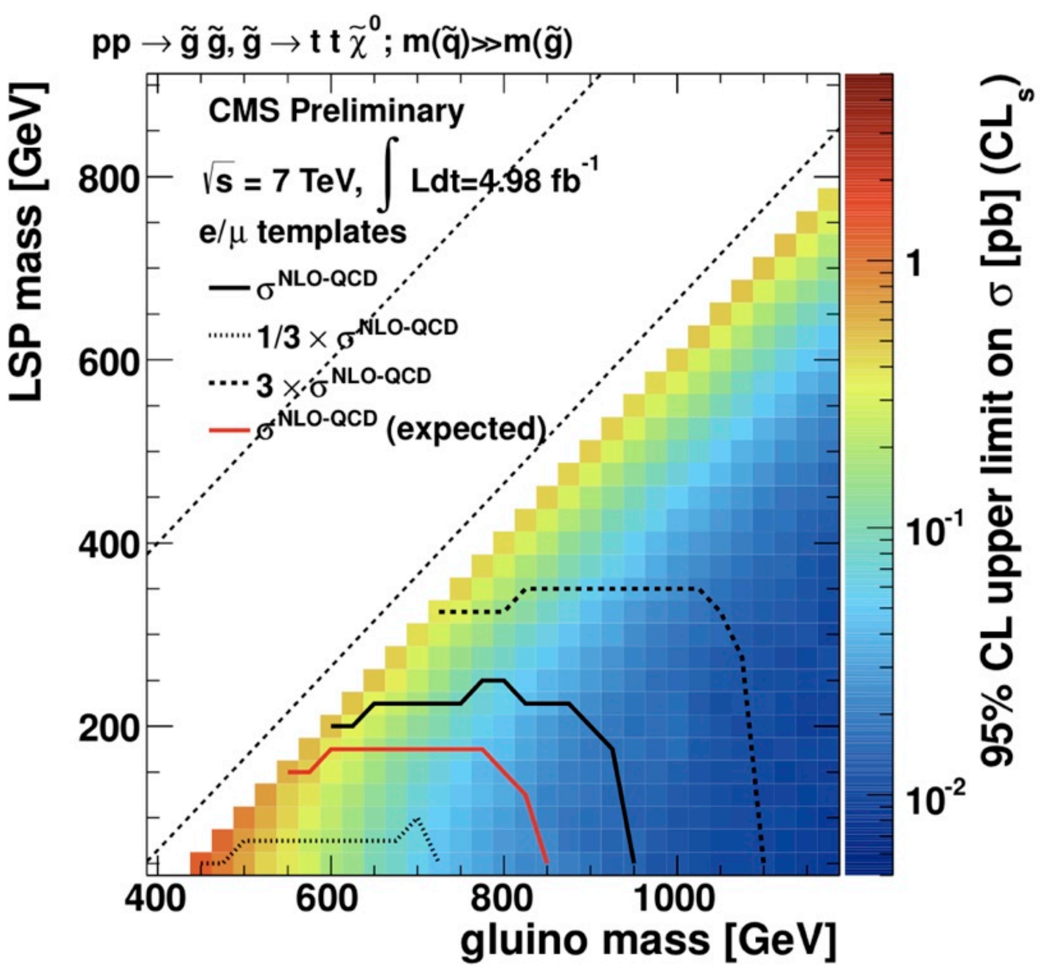
<u>Event selections:</u>

- $\geq$3 jets p_T>40 GeV
- $H_T\geq$350 GeV, E_T^{miss}>100 GeV
- $\geq$1 lepton p_T > 20 GeV
- Fit parameters obtained in low H_T, E_T^{miss} region and extrapolated to SR

Event yield vs H_T, E_T^{miss}

	$H_T > 750$ GeV				$H_T > 1000$ GeV			
	predicted	stat.	sys.	obs.	predicted	stat.	sys.	obs.
	$E_T^{miss} > 250$ GeV							
total	145.82	± 9.28	± 23.73	137	37.54	± 3.73	± 8.85	36
0-tag	98.95	± 7.54	± 18.11	97	27.02	± 3.19	± 7.01	30
1-tag	34.62	± 2.76	± 7.54	35	7.51	± 1.18	± 2.58	5
$\geq$ 1-tag	46.87	± 3.09	± 10.18	40	10.52	± 1.33	± 3.61	6
$\geq$ 2-tag	12.26	± 1.38	± 2.68	5	3.01	± 0.61	± 1.03	1
	$E_T^{miss} > 350$ GeV							
total	53.55	± 4.54	± 11.75	44	15.49	± 1.73	± 4.94	13
0-tag	38.72	± 3.59	± 9.52	32	11.66	± 1.55	± 4.15	11
1-tag	11.51	± 1.03	± 3.5	11	2.87	± 0.46	± 1.36	2
$\geq$ 1-tag	14.83	± 1.11	± 4.5	12	3.83	± 0.5	± 1.81	2
$\geq$ 2-tag	3.32	± 0.4	± 1.02	1	0.96	± 0.2	± 0.46	0
	$E_T^{miss} > 450$ GeV							
total	19.62	± 2.05	± 6.19	20	6.58	± 0.86	± 2.77	7
0-tag	14.93	± 1.7	± 5.18	14	5.15	± 0.76	± 2.31	6
1-tag	3.84	± 0.4	± 1.5	5	1.14	± 0.2	± 0.67	1
$\geq$ 1-tag	4.69	± 0.42	± 1.83	6	1.43	± 0.21	± 0.86	1
$\geq$ 2-tag	0.85	± 0.12	± 0.33	1	0.29	± 0.07	± 0.19	0

PAS-SUS-11-027



Limits obtained in simplified "Gtt" model:
gluino ≲ 0.9 TeV (neutralino ≲200 GeV)

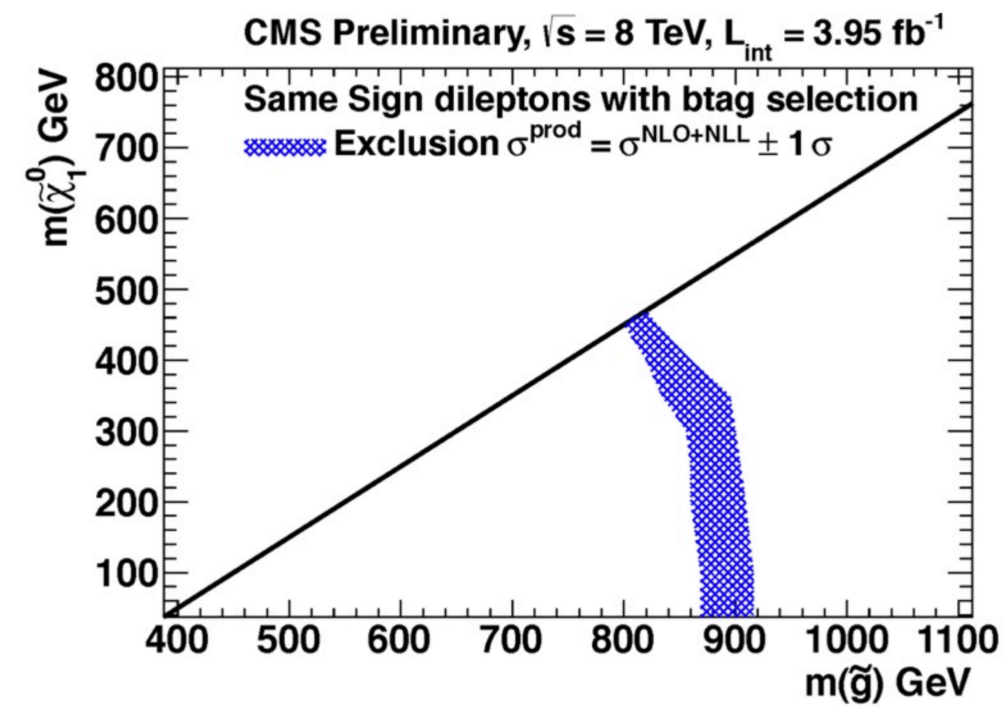
A complementary analysis with the same signature extracts the bkgd using ABCD technique with H_T and E_T^{miss}/H_T: <u>PAS-SUS-11-028</u>

CMS Same-sign 2 ℓ + b-jets (8 TeV)

Selections and backgrounds:

- ==2 leptons p_T>20 GeV
- ≥2 jets with p_T>40 GeV, ≥2 b-tags
- Background dominated by ttbarV
- Also important are the fake leptons and electron charge-flips

Limits obtained in simplified "Gtt" model
gluino ≲ 0.9 TeV, LSP exclusion up-to 450 GeV (low E_T^{miss} cut)



Event yield vs njets, H_T, E_T^{miss}:

	SR0	SR1	SR2	SR3	SR4	SR5	SR6	SR7	SR8
No. of jets	≥ 2	≥ 2	≥ 2	≥ 2	≥ 2	≥ 2	≥ 2	≥ 3	≥ 2
No. of b-tags	≥ 2	≥ 2	≥ 2	≥ 2	≥ 2	≥ 2	≥ 2	≥ 3	≥ 2
Lepton charges	$++/--$	$++/--$	$++$	$++/--$	$++/--$	$++/--$	$++/--$	$++/--$	$++/--$
E_T^{miss}	> 0 GeV	> 30 GeV	> 30 GeV	> 120 GeV	> 50 GeV	> 50 GeV	> 120 GeV	> 50 GeV	> 0 GeV
H_T	> 80 GeV	> 80 GeV	> 80 GeV	> 200 GeV	> 200 GeV	> 320 GeV	> 320 GeV	> 200 GeV	> 320 GeV
Charge-flip BG	1.32 ± 0.28	1.04 ± 0.22	0.52 ± 0.11	0.05 ± 0.01	0.35 ± 0.08	0.11 ± 0.03	0.02 ± 0.01	0.01 ± 0.01	0.18 ± 0.05
Fake BG	5.89 ± 3.78	4.46 ± 2.68	1.86 ± 1.12	0.33 ± 0.36	2.46 ± 2.16	0.77 ± 0.82	0.20 ± 0.33	0.08 ± 0.52	1.36 ± 1.12
Rare SM BG	4.92 ± 2.57	4.44 ± 2.32	2.95 ± 1.59	1.01 ± 0.62	2.95 ± 1.56	1.77 ± 1.03	0.71 ± 0.51	0.24 ± 0.40	2.24 ± 1.27
Total BG	12.13 ± 4.58	9.94 ± 3.55	5.33 ± 1.95	1.39 ± 0.72	5.76 ± 2.67	2.64 ± 1.32	0.93 ± 0.61	0.33 ± 0.66	3.78 ± 1.69
Event yield	13	11	0	1	4	2	1	1	4

8 TeV: PAS-SUS-12-017

7 TeV paper: arXiv:1205.3933

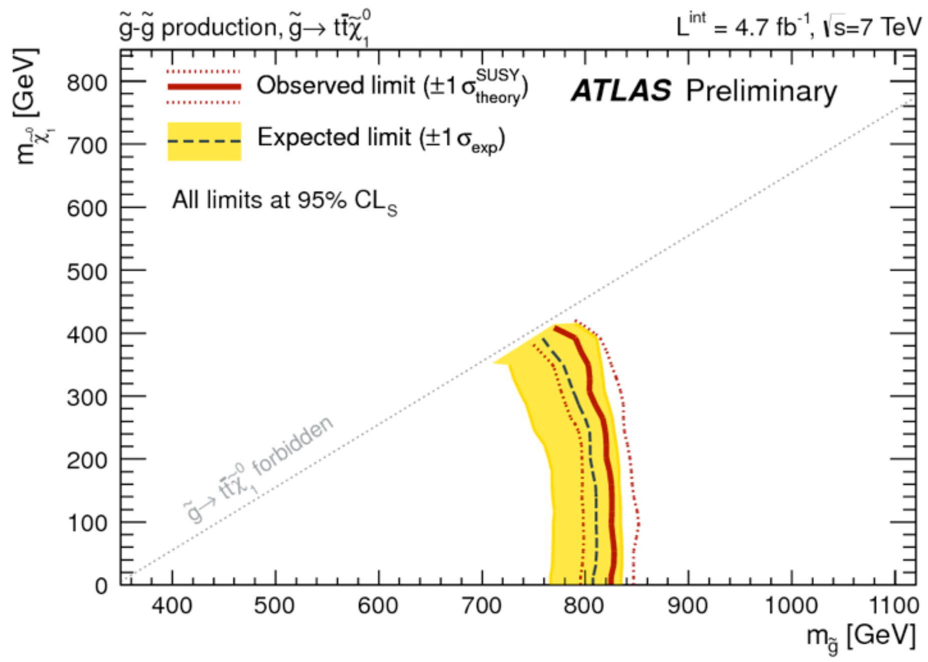
ATLAS: also has 8 TeV SS+jets analysis with "Gtt" interpretation and comparable limits: *ATLAS-CONF-2012-105*

ATLAS 3 ℓ + jets + E_T^{miss} (7 TeV)

<u>Selections and backgrounds:</u>

- $\geq$3 leptons p_T>15 GeV (leading p_T> 20 (23) GeV for μ (e)
- $\geq$4 jets with p_T>30 GeV, $\geq$2 b-tags
- E_T^{miss}>50 GeV
- Background dominated by fake leptons and estimated from dedicated CR

Limits obtained in simplified "Gtt" model
gluino ≲ 0.8 TeV, LSP exclusion up-to 380 GeV (low E_T^{miss} cut)

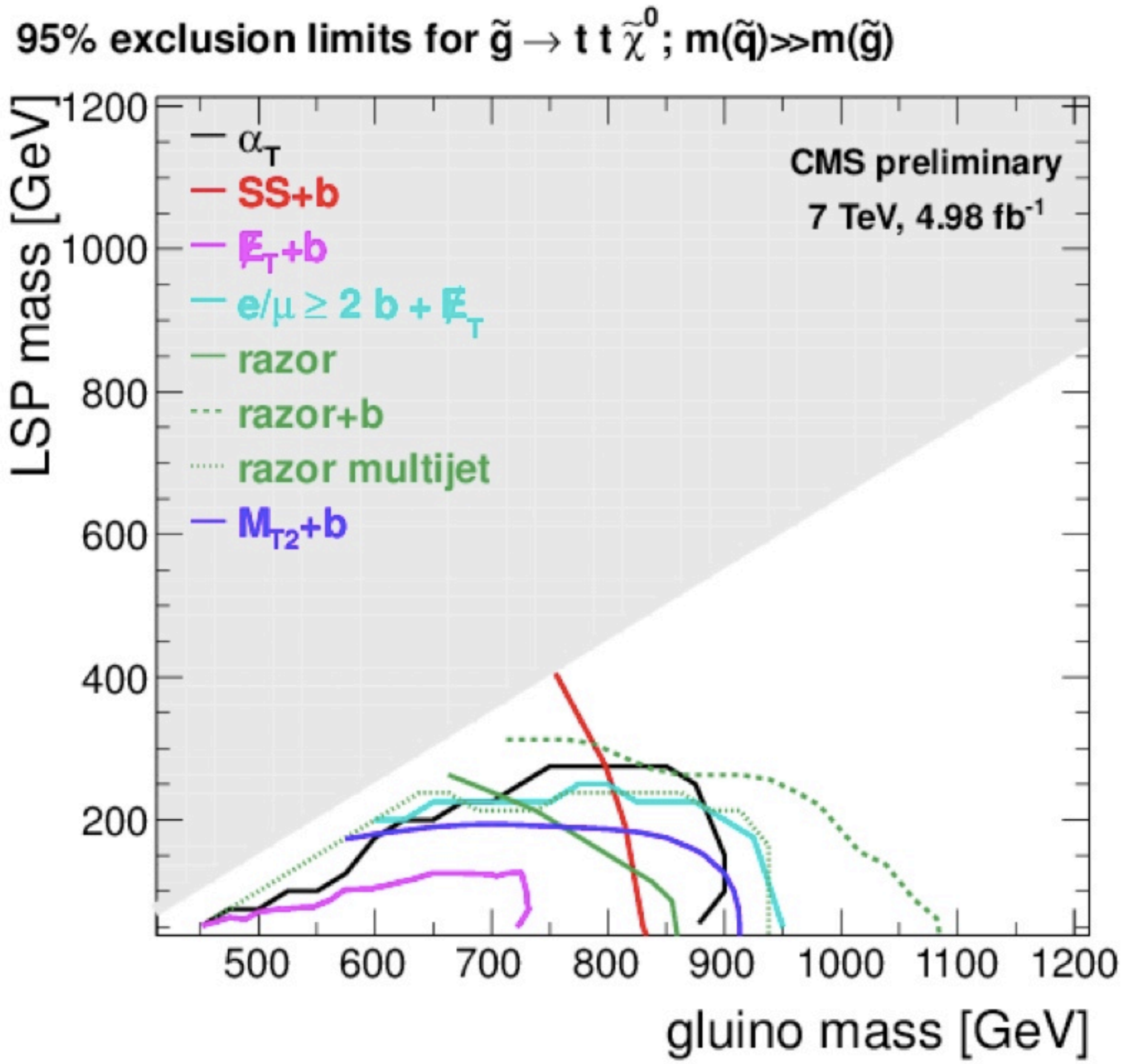


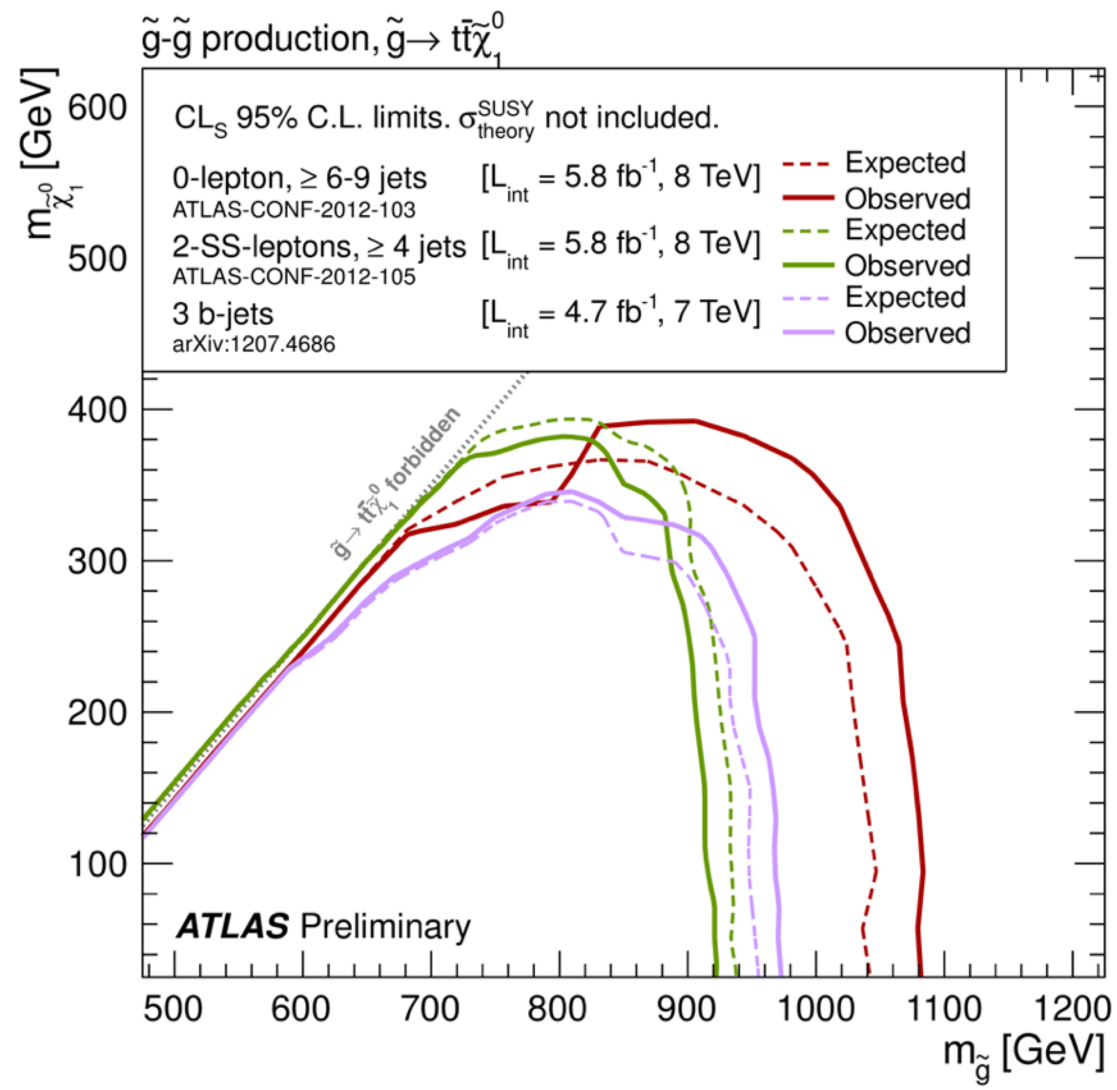
Event yield vs lepton flavors

	0e	1eSS	1eOS	2eSS	2eOS	3e	3ℓ
$t\bar{t}$	0.1±0.1	0.2±0.1	0.4±0.3	0.6±0.4	0.5±0.2	0.4±0.2	2.2±0.9
$t\bar{t}+V$	0.1±0.1	0.1±0.0	0.1±0.1	0.1±0.1	0.1±0.1	0.0±0.0	0.5±0.4
Wt	0±0	0±0	0±0	0±0	0±0	0±0	0±0
di-bosons	0.1±0.1	0.0±0.0	0.2±0.1	0.0±0.0	0.1±0.1	0.2±0.1	0.6±0.2
Z+jets	0±0	0±0	$0.1^{+0.2}_{-0.1}$	0±0	0±0	0±0	$0.1^{+0.2}_{-0.1}$
Total SM	0.3±0.2	0.3±0.1	0.8±0.4	0.7±0.4	0.7±0.3	0.6±0.3	3.4±1.2
Data	0	0	1	0	1	0	2

ATLAS-CONF-2012-108

Summary of gluino-mediated limited

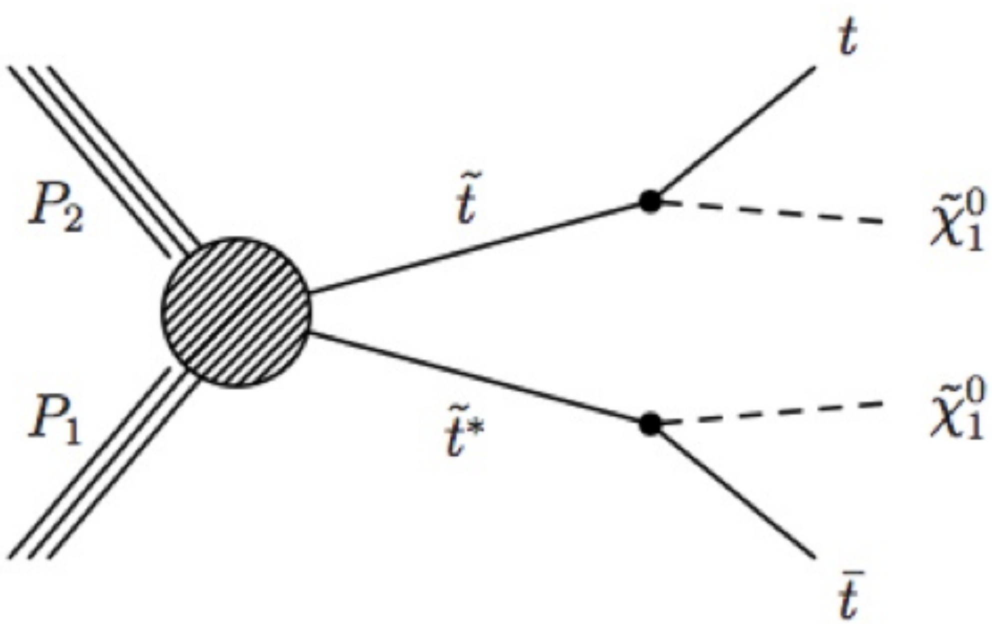


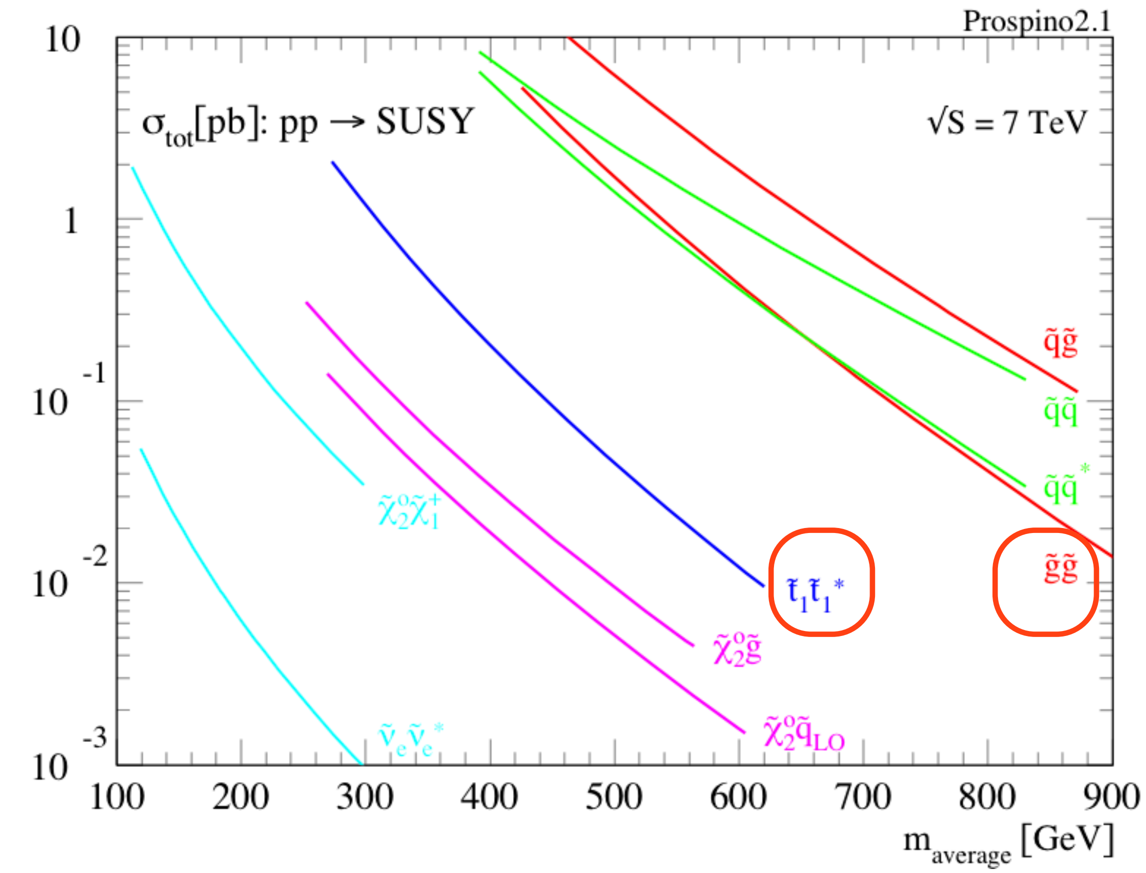


Several of the presented analyses also provide limits for:

- Gluino-mediated **real** stop production
- Direct sbottom, sbottom → top chargino (→$W^{\pm}$ LSP)
- Gluino-mediated sbottom production

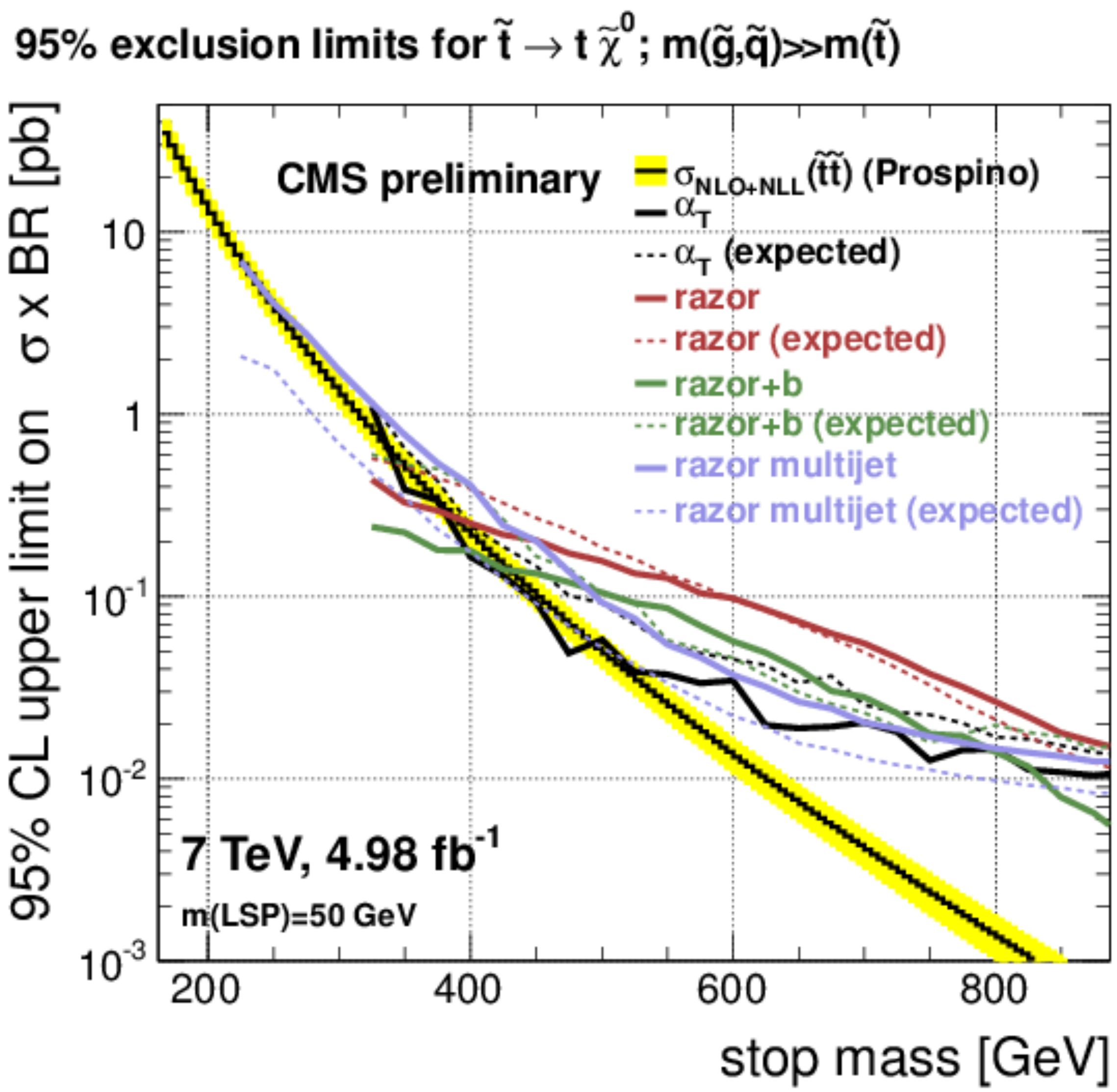
Direct production

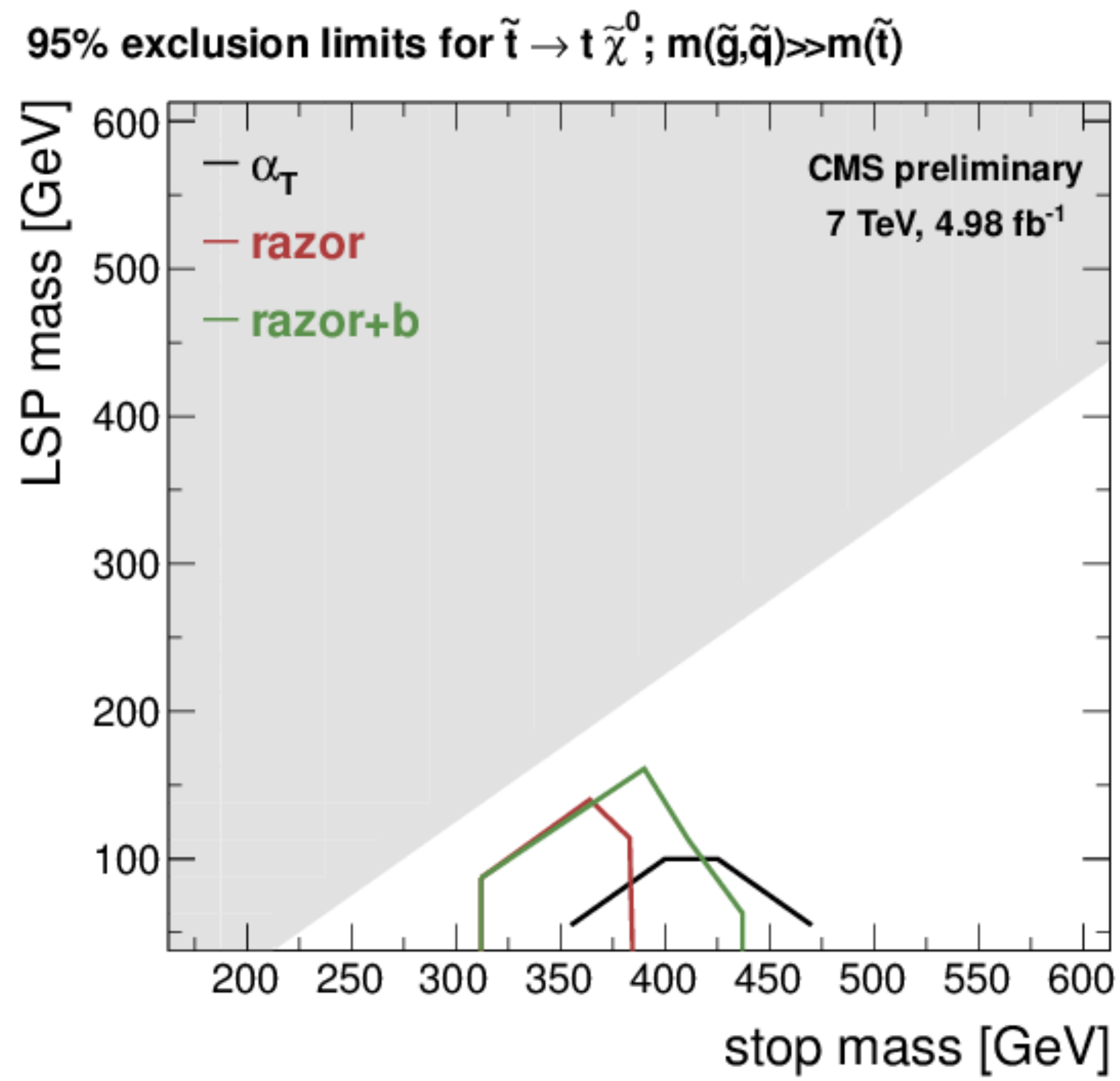




Also if stop is lighter than the top: stop → bottom chargino (chargino → $W^{(*)}$ LSP)

CMS 0 ℓ analyses interpreted for direct stop (7 TeV)





Dedicated direct stop searches are currently in the works

ATLAS direct stop 0 ℓ analysis (7 TeV)

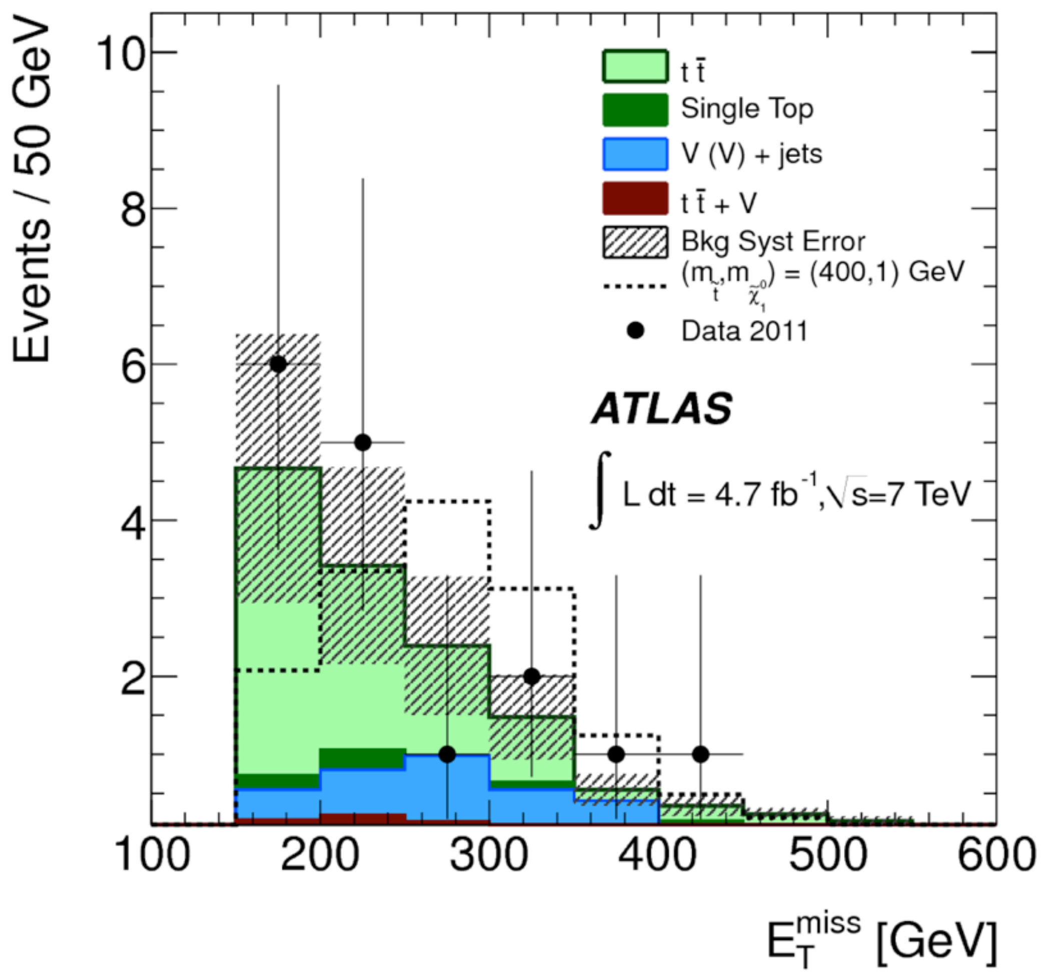
Selections and background

- ≥6 jets p_T>30GeV, leading jet p_T>130GeV, 1 or 2 b-tags
- QCD bkgd reduced with Δφ cut of E_T^{miss} with jets, E_T^{miss}(trk)
- Cuts on m_T(b-jet, E_T^{miss}) and m_{jjj}
- Background dominated by ttbar ℓ +jets bkgd (e.g. τ)
  - τ-jet veto (M_T<100 GeV)

arXiv 1208.1447
(submitted to PRL)

Event yield for two E_T^{miss} cuts

	SRA	SRB
E_T^{miss}	> 150 GeV	> 260 GeV
$t\bar{t}$	9.2 ± 2.7	2.3 ± 0.6
$t\bar{t} + W/Z$	0.8 ± 0.2	0.4 ± 0.1
Single top	0.7 ± 0.4	$0.2\ ^{+\,0.3}_{-\,0.2}$
Z+jets	$1.3\ ^{+\,1.1}_{-\,1.0}$	$0.9\ ^{+\,0.8}_{-\,0.7}$
W+jets	$1.2\ ^{+\,1.4}_{-\,1.0}$	0.5 ± 0.4
Diboson	$0.1\ ^{+\,0.2}_{-\,0.1}$	$0.1\ ^{+\,0.2}_{-\,0.1}$
Multi-jets	0.2 ± 0.2	0.02 ± 0.02
Total SM	$13.5\ ^{+\,3.7}_{-\,3.6}$	$4.4\ ^{+\,1.7}_{-\,1.3}$
SUSY $(m_{\tilde{t}_1}, m_{\tilde{\chi}_1^0}) = (400, 1)$ GeV	14.8 ± 4.0	8.9 ± 3.1
Data (observed)	16	4
Visible cross section [fb]	2.9 (2.5)	1.3 (1.3)

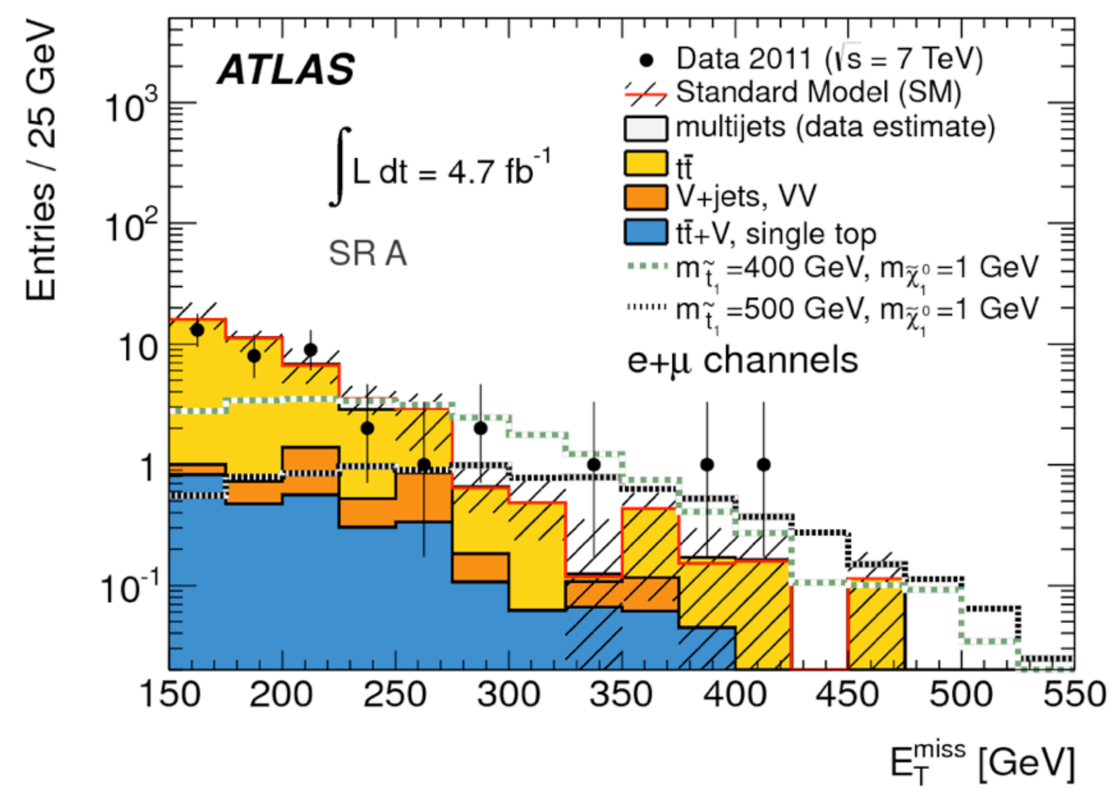


Stop excluded between 370-465 GeV for m_{LSP}=0 and (max LSP exclusion is 50 GeV)

ATLAS direct stop 1 ℓ analysis (7 TeV)

Selections and background

- Exactly one lepton
- ≥4 jets p_T>80, 60, 40, 25 GeV, ≥1 b-tag
- Δφ cut of E_T^{miss} with two lead jet > 0.8
- 130 < m_{jjj} < 205 GeV



Optimized selections:

Requirement	SR A	SR B	SR C	SR D	SR E
E_T^{miss} [GeV] >	150	150	150	225	275
$E_T^{miss}/\sqrt{H_T}$ [GeV$^{1/2}$] >	7	9	11	11	11
m_T [GeV] >	120	120	120	130	140

Regions	SR A	SR B	SR C	SR D	SR E
$t\bar{t}$	36 ± 5	27 ± 4	11 ± 2	4.9 ± 1.3	1.3 ± 0.6
$t\bar{t} + V$, single top	2.9 ± 0.7	2.5 ± 0.6	1.6 ± 0.3	0.9 ± 0.3	0.4 ± 0.1
V+jets, VV	2.5 ± 1.3	1.7 ± 0.8	0.4 ± 0.1	0.3 ± 0.1	0.1 ± 0.1
Multijet	0.4 ± 0.4	0.3 ± 0.3	0.3 ± 0.3	0.3 ± 0.3	$0.0^{+0.3}_{-0.0}$
Total background	42 ± 6	31 ± 4	13 ± 2	6.4 ± 1.4	1.8 ± 0.7
Signal benchmark 1 (2)	25.6 (8.8)	23.0 (8.1)	17.5 (6.9)	13.5 (6.2)	7.1 (4.5)
Observed events	38	25	15	8	5

arXiv 1208.2590
(submitted to PRL)

Stop excluded between 230-440 GeV for m_{LSP}=0 and (max LSP exclusion is 125 GeV)

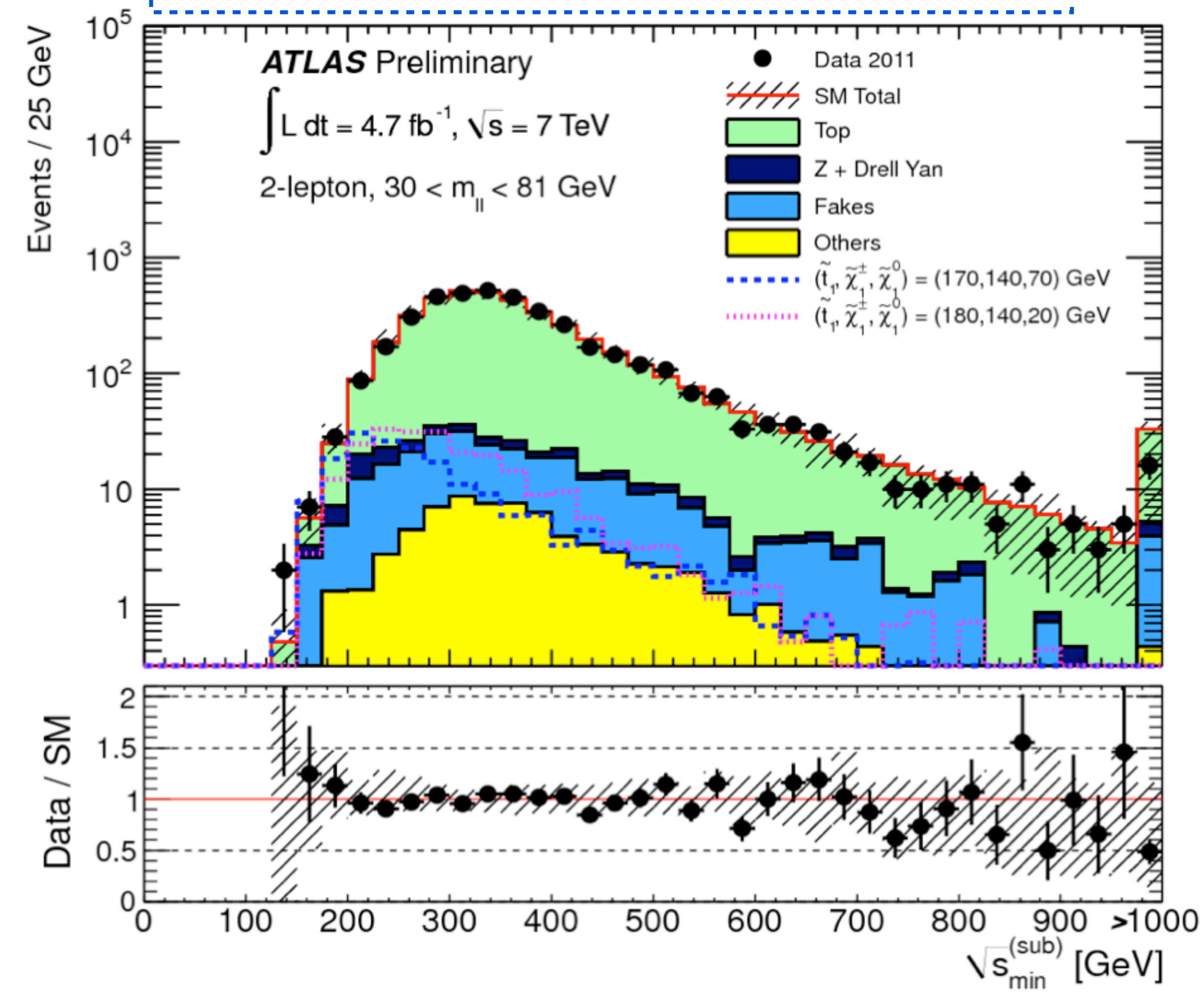
ATLAS **light** stop 1-2 ℓ + b-jets (7 TeV)

m_{stop} < m_{top} → stop → bottom chargino, chargino → W(*) LSP
All objects are softer → **challenging!**

<u>1-lepton selections</u>
- p_T(lep) > 20-25 GeV, ≥4 jets p_T>20 GeV
- 2 b-tags, E_T^{miss}>40 GeV, m_T>30 GeV
- Require low reco. top mass

<u>2-lepton selections</u>
- 2 OS leptons, ≥2 jets, 1 b-tag
- E_T^{miss}>40 GeV, Z mass veto

Minimum mass scale variable used to discriminate S/B



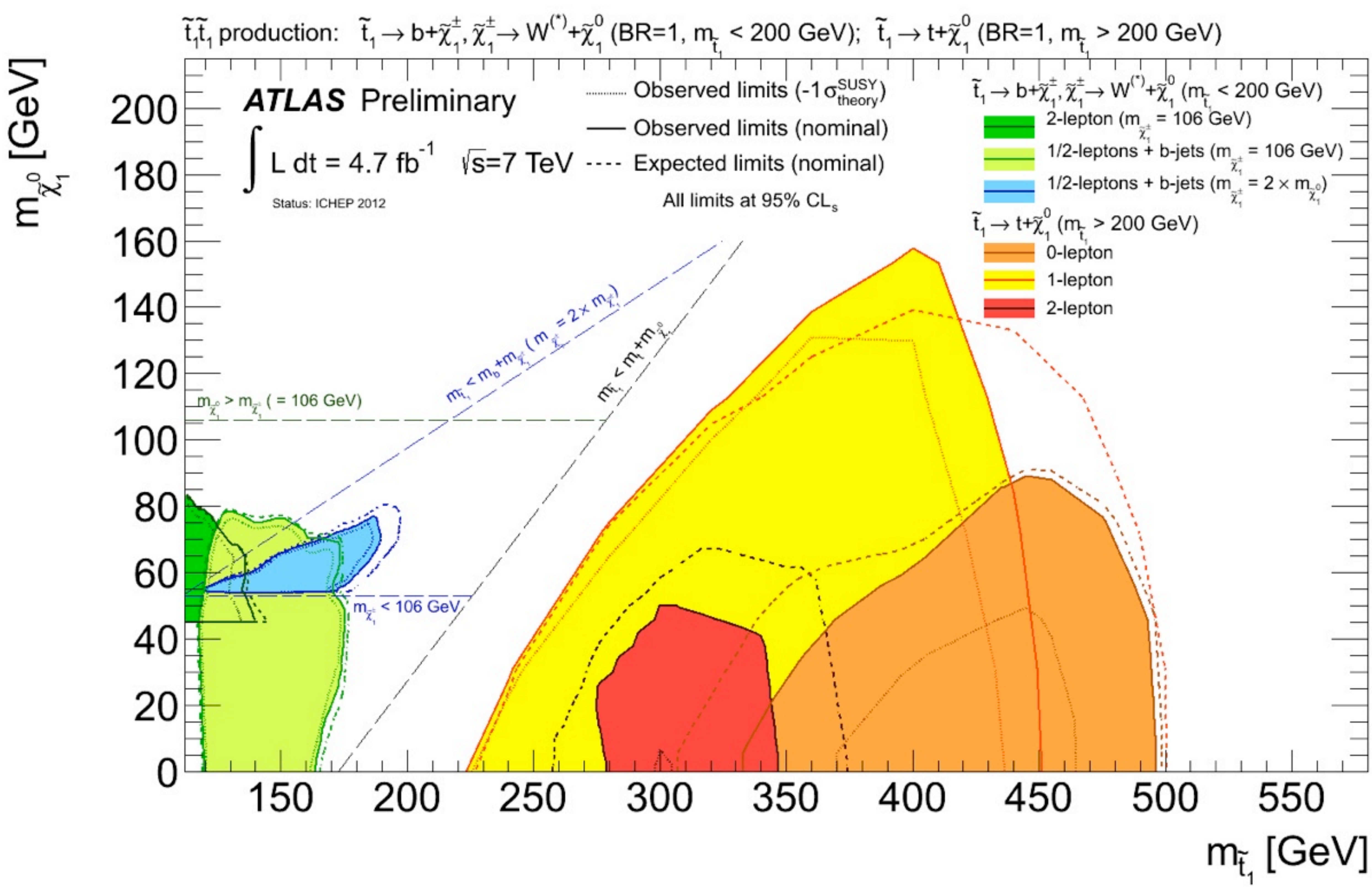
Signal event yields

Process	Number of events 1LSR	2LSR1	2LSR2
Top	$24\pm3\pm5$	$89\pm6\pm10$	$36\pm2\pm5$
W+jets	$6\pm1\pm2$	n/a	n/a
Z+jets	$0.5\pm0.3\pm0.3$	$11\pm4\pm3$	$3\pm1\pm1$
Fake leptons	$7\pm1\pm2$	$12\pm5\pm11$	$6\pm4\pm4$
Others	$0.3\pm0.1\pm0.1$	$2.7\pm0.9\pm0.7$	$0.9\pm0.2\pm0.5$
Total SM	$38\pm3\pm7$	$115\pm8\pm15$	$46\pm4\pm7$
Data	50	123	47
$m_{\tilde{t}_1}=170$ GeV, $m_{\tilde{\chi}_1^0}=70$ GeV	$26\pm2\pm6$	$57\pm3\pm6$	$36\pm2\pm4$
$m_{\tilde{t}_1}=180$ GeV, $m_{\tilde{\chi}_1^0}=20$ GeV	$20\pm2\pm4$	$41\pm3\pm5$	$27\pm2\pm3$
	95% CL upper limits		
σ_{vis} (expected) [fb]	4.2	9.3	4.6
σ_{vis} (observed) [fb]	6.1	11	5.2

Stop excluded for mass ~120-170 GeV for m_{LSP}=55 GeV ($\chi_1^{\pm}$=106 GeV)

ATLAS-CONF-2012-070

Summary of ATLAS direct stop searches

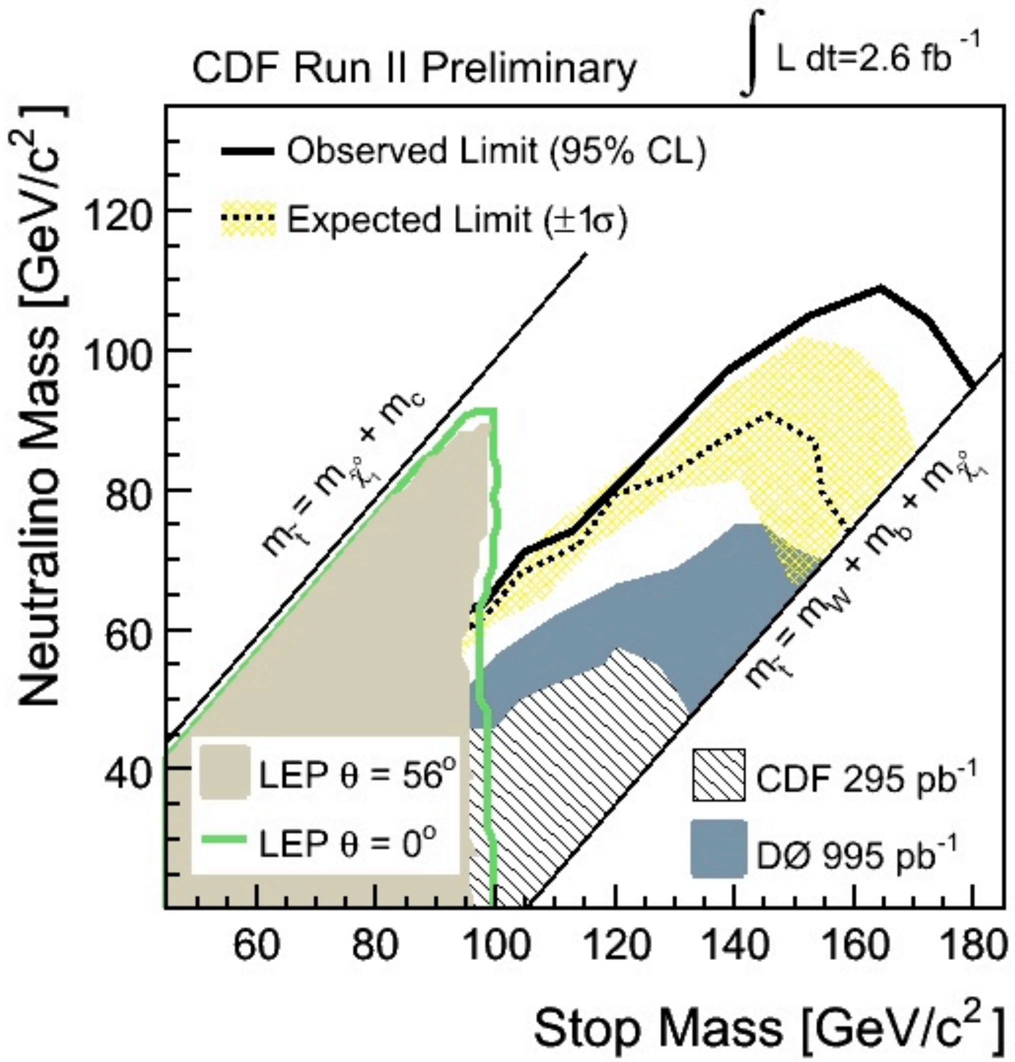


Highlights of direct stop limit from Tevatron

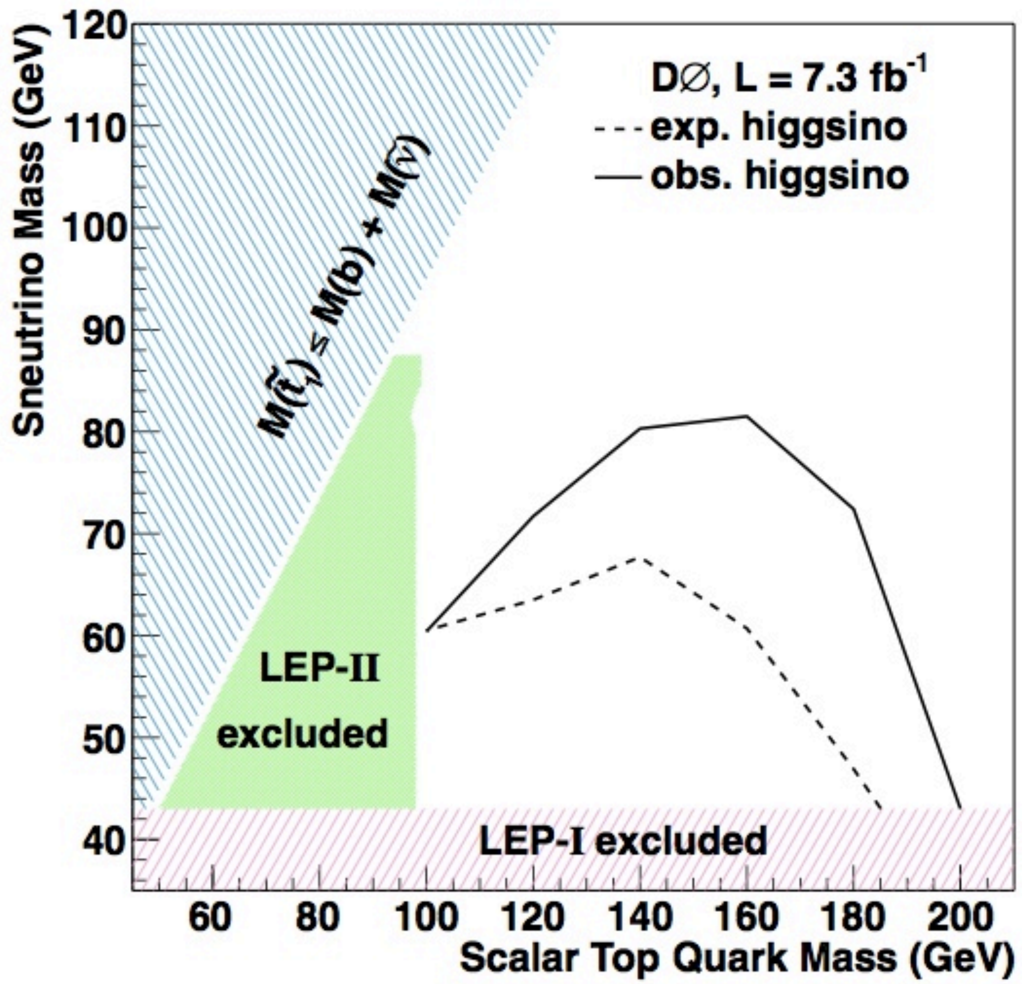
- The stop has been looked for in several channels at the Tevatron
- stop → top LSP is kinematically disfavored → specialize in lighter stop signatures

If stop is very light (and heavier chargino or neutralino), favored decay could be to **charm quark and LSP**

Other possible scenarios for very light stop: three-body decays to b ℓ sneutrino



arXiv:1203.4171



μ+τ: *PLB 710, 578 (2012)*

Also: e+μ: PLB 696, 321 (2011)

Conclusions

- 2012 has been a **special year for the interplay of top/SUSY physics** as the interest for **3rd generation SUSY** has increased dramatically
- A **significant part** of the **natural phase space** of SUSY has been **excluded**
- But the searches continues, there is **still a lot of important (majority of) territory left to cover** → will largely benefit from $\sqrt{s}$=8 TeV and higher luminosity
- **ttbar background is typically dominant** (in 3rd generation and inclusive searches) → several complementary methods developed
- Note: I did not cover analyses looking for SUSY signatures like EW production, RPV, long-lived particles, etc

CMS SUSY public results

ATLAS SUSY public results

CDF Exotics results

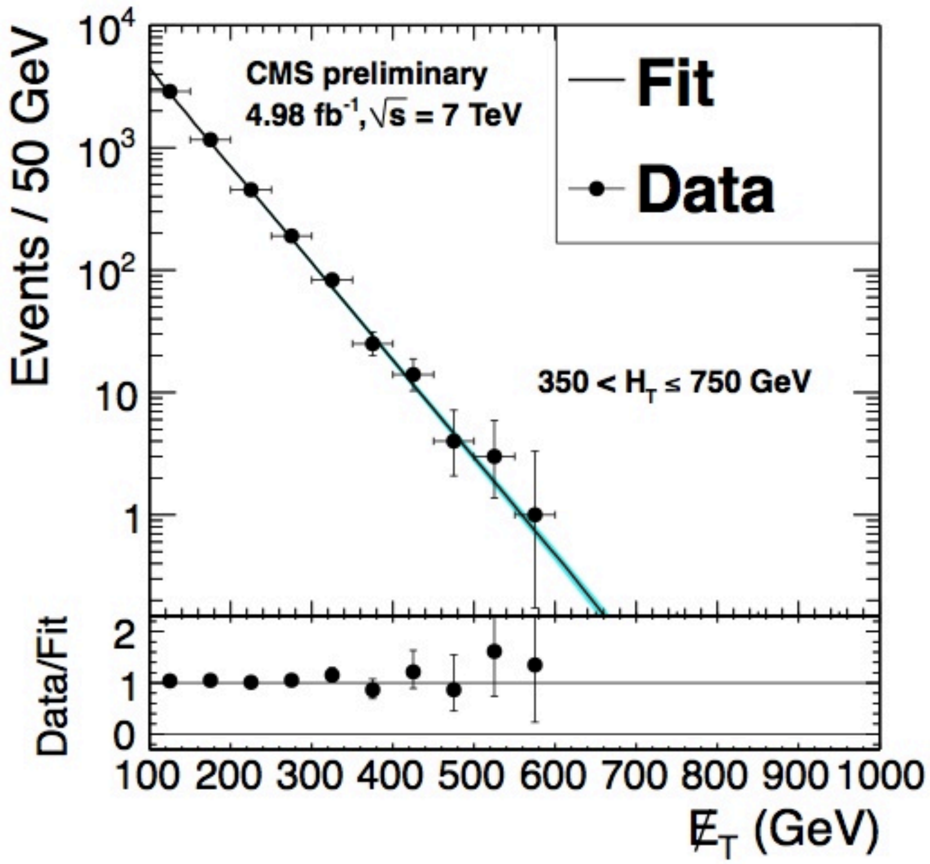
DØ New Phenomena results

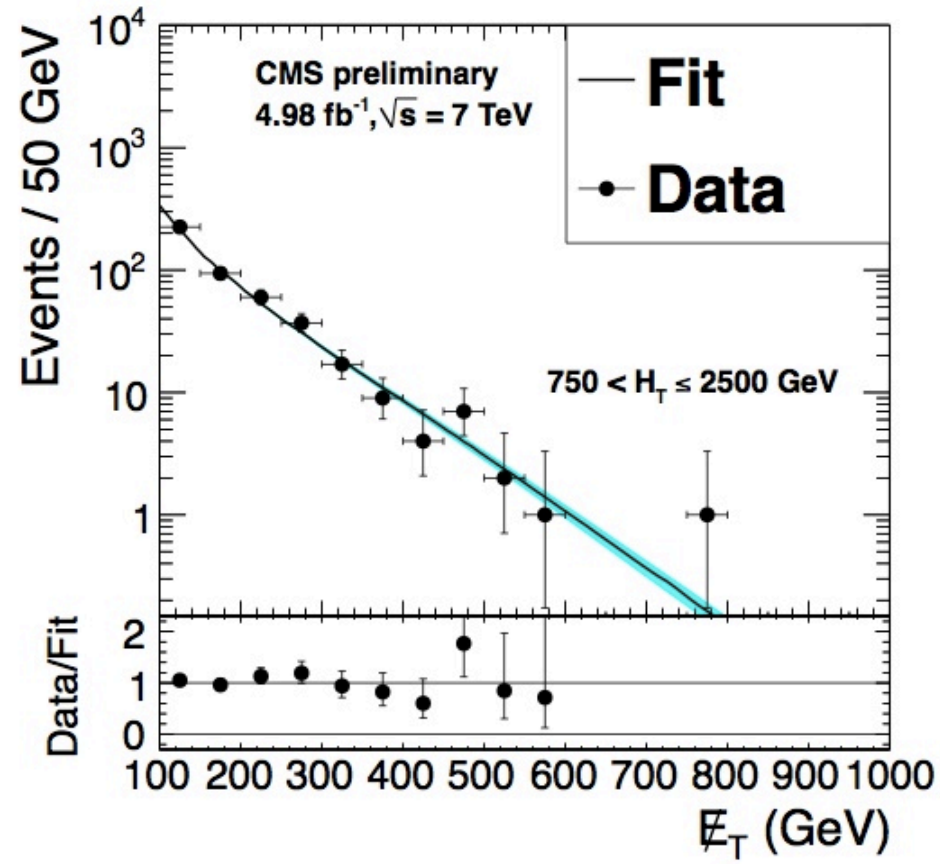
Additional material

CMS 1 ℓ + **b-**jets + E_T^{miss} (7 TeV)

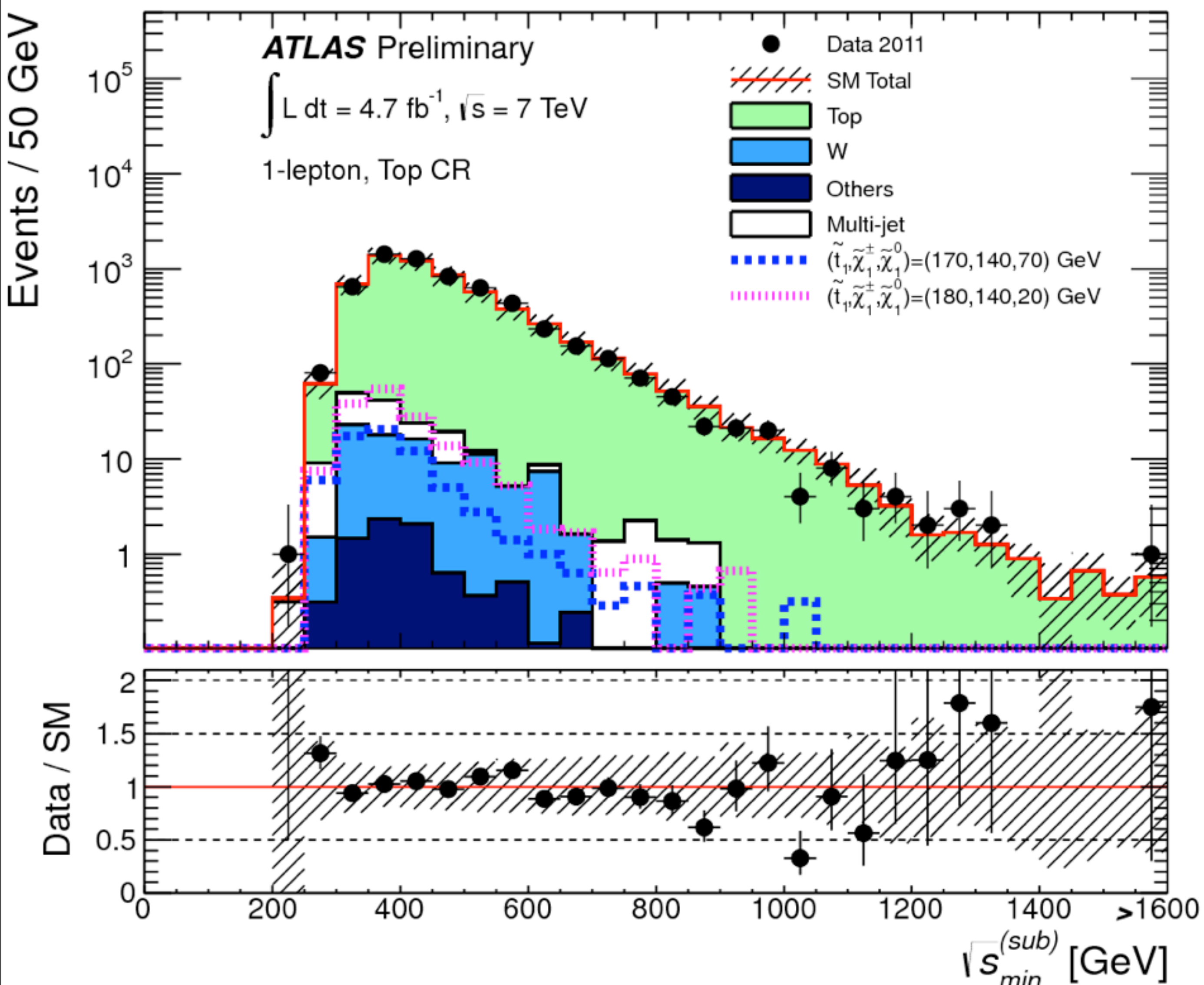
Table 5: Relative systematic uncertainties for the background estimation in the signal region $H_T > 1000$ GeV and $250 < E_T^{miss} < 2500$ GeV.

	μ channel			e channel		
Source	total	0-tag	$\geq$ 1-tag	total	0-tag	$\geq$ 1-tag
Jet and E_T^{miss} scale	6.0 %	7.5 %	7.2 %	3.1 %	5.6 %	2.1 %
W polarization (1), $\pm$10%	0.5 %	0.6 %	0.1 %	1.3 %	1.8 %	0.2 %
W^- polarization (2), $\pm$5%	0.3 %	0.5 %	0.1 %	0.5 %	0.5 %	0.2 %
W^+ polarization (2), $\pm$5%	0.1 %	0.2 %	0.1 %	0.1 %	0.1 %	0.1 %
W polarization (3), $\pm$ 10%	0.0 %	0.1 %	0.0 %	0.5 %	0.6 %	0.2 %
vary lep. eff. at low p_T	0.4 %	0.3 %	0.6 %	0.6 %	1.3 %	0.7 %
vary lep. eff. in endcaps	0.2 %	0.2 %	0.1 %	0.6 %	0.8 %	0.4 %
vary pile-up	0.1 %	0.1 %	0.2 %	0.3 %	1.5 %	0.4 %
Non-leading bkg $\pm$ 50%	0.7 %	0.4 %	0.4 %	4.0 %	3.0 %	6.2 %
dilep. contr $\pm$ 50%	0.1 %	0.5 %	0.7 %	0.6 %	1.2 %	0.6 %
$\sigma(t\bar{t})$, $\pm$ 32%	1.2 %	2.3 %	1.6 %	0.7 %	1.8 %	2.0 %
σ(W+jets), $\pm$ 32%	1.3 %	2.9 %	2.3 %	2.6 %	1.6 %	2.8 %
exponent $t\bar{t}$ $\pm$ 10%	1.6 %	0.2 %	5.3 %	1.8 %	0.3 %	4.8 %
exponent W^++jets $\pm$ 10%	3.5 %	4.4 %	1.3 %	3.6 %	4.6 %	1.5 %
exponent W^-+jets $\pm$ 10%	0.7 %	0.8 %	0.3 %	0.9 %	1.4 %	0.9 %
α slope $t\bar{t}$	11.0 %	2.4 %	29.3 %	14.8 %	5.0 %	34.3 %
α slope W^++jets	15.9 %	20.6 %	6.0 %	16.5 %	22.2 %	5.1 %
α slope W^-+jets	4.9 %	8.2 %	2.0 %	5.6 %	8.7 %	0.5 %
Variation of Erfc.	4.1 %	4.6 %	2.9 %	3.1 %	3.2 %	2.7 %





ATLAS light stop 1-2 ℓ + b-jets: more info



Minimum invariant mass compatible with the subsystem

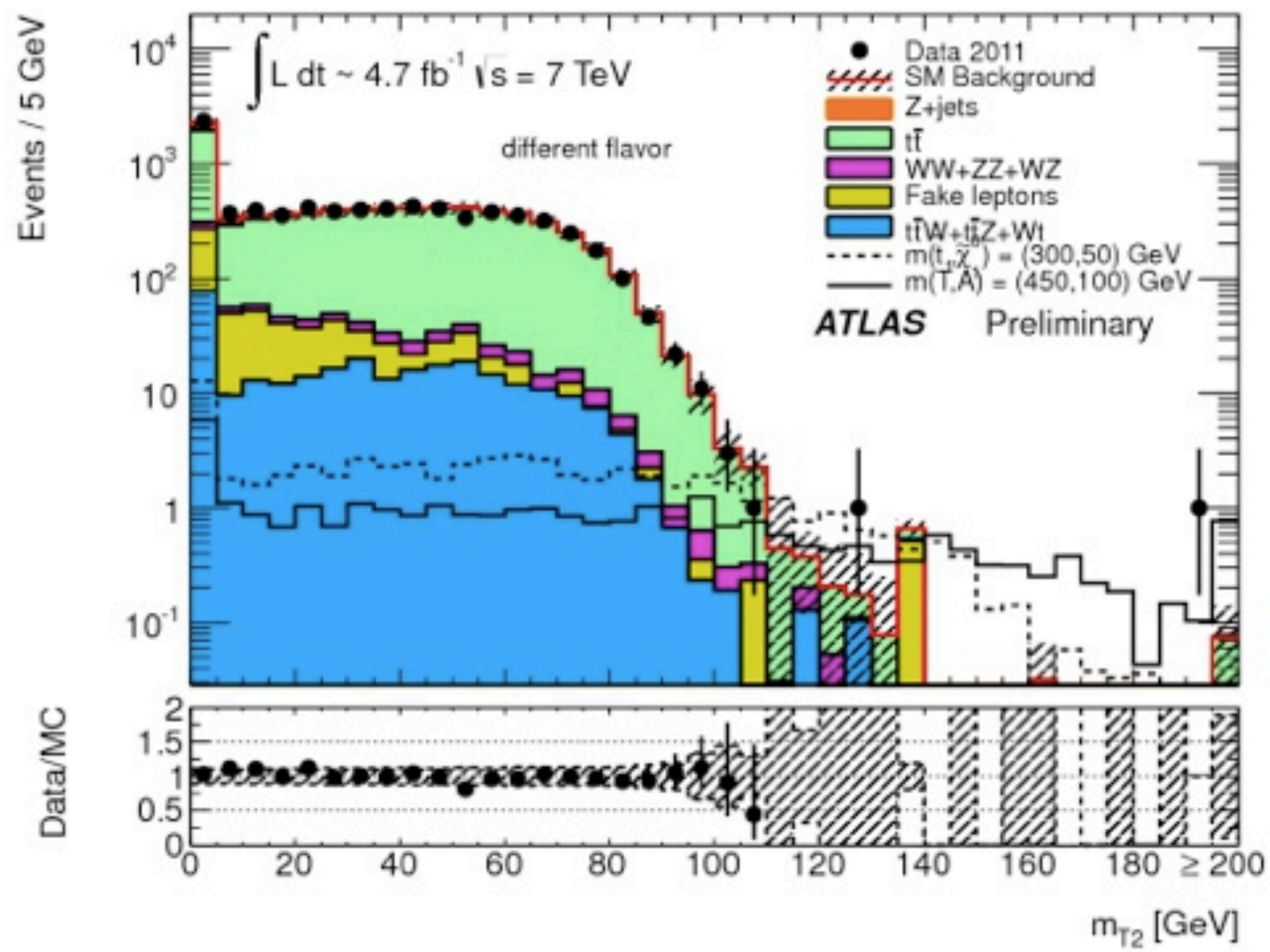
$$\sqrt{s}_{min}^{(sub)} = \left\{ \left(\sqrt{m_{(sub)}^2 + p_{T(sub)}^2} + \sqrt{(m^{miss})^2 + (E_T^{miss})^2} \right)^2 - \left(\mathbf{p}_{T(sub)} + \mathbf{p}_T^{miss} \right)^2 \right\}^{\frac{1}{2}},$$

ATLAS direct stop 2 ℓ analysis (7 TeV)

Selections and background

- ==2 leptons and ≥2 jets
- Same-flavor leptons: Z veto and b-tag
- Signal region: m_{T2}>120 GeV

	SF	DF
$Z/\gamma^{\star}$+jets	1.2 ± 0.5	-
($Z/\gamma^{\star}$+jets scale factor)	(1.27)	-
$t\bar{t}$	0.23 ± 0.23	0.4 ± 0.3
($t\bar{t}$ scale factor)	(1.21)	(1.10)
$t\bar{t}W + t\bar{t}Z$	0.11 ± 0.07	0.19 ± 0.12
WW	$0.01^{+0.02}_{-0.01}$	0.19 ± 0.18
$WZ + ZZ$	0.05 ± 0.05	0.03 ± 0.03
Wt	$0.00^{+0.17}_{-0.00}$	$0.10^{+0.18}_{-0.10}$
Fake leptons	$0.00^{+0.14}_{-0.00}$	$0.00^{+0.09}_{-0.00}$
Total SM	1.6 ± 0.6	0.9 ± 0.6
Signal, $m(\tilde{t}_1) = 300$ GeV, $m(\tilde{\chi}^0_1) = 50$ GeV	2.15	3.73
Signal, $m(T) = 450$ GeV, $m(A_0) = 100$ GeV	3.10	5.78
Observed	1	2
95% CL limit on $\sigma^{\rm obs}_{\rm vis}$[fb]	0.86	1.08
95% CL limit on $\sigma^{\rm exp}_{\rm vis}$[fb]	0.89	0.79



ATLAS-CONF-2012-071

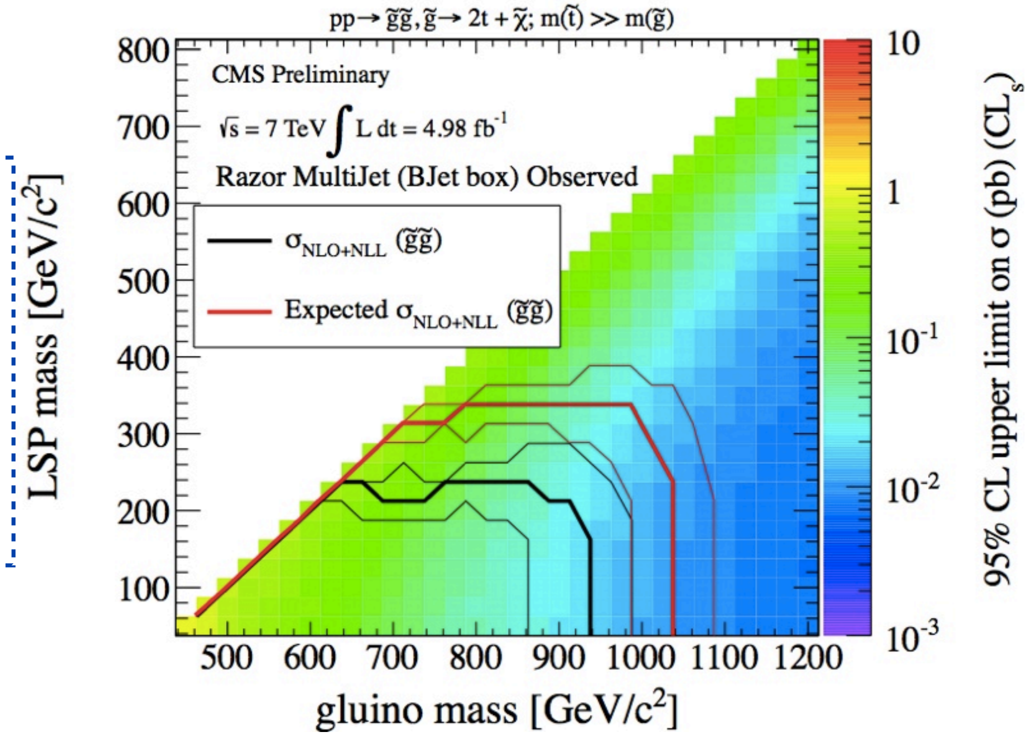
Stop excluded for mass ~300 GeV for m_{LSP}=0

CMS Razor 0 ℓ multijet+**b**-jets (7 TeV)

Event selections:

- ≥6 jets p_T>30 GeV
- ≥2 jets p_T>80 GeV
- ≥1 jet b-tag
- Isolated lepton veto
- Use "razor" variables to discriminate signal and bkgd

Limits obtained in simplified "Gtt" model
gluino ≲ 0.9 TeV (LSP ≲ 220 GeV)



Event yield:

SUS-12-009

Region	M_R	R^2	Observed	Predicted Mode	Predicted Median	Predicted 68 Prob. Range	p-value
S_1	[3000, 4000]	[0.0300, 0.0375]	0	0.5	0.5	2.5 ± 2.5	0.99
S_2	[800, 4000]	[0.0375, 0.0900]	4328	4318.5	3709.5	4426.5 ± 718.5	0.40
S_3	[650, 4000]	[0.0900, 0.2000]	551	504.5	500.5	640.5 ± 140.5	0.43
S_4	[600, 4000]	[0.2000, 0.3000]	37	33.5	11.5	37.0 ± 27.0	0.84
S_5	[550, 4000]	[0.3000, 0.5000]	7	9.5	1.5	14.0 ± 14.0	0.70
S_6	[500, 4000]	[0.5000, 1.0000]	0	0.5	0.5	3.0 ± 3.0	0.99

CMS has several other 0 ℓ analyses interpreted in gluino-mediated stop production:

- Two more Razor analyses (7 TeV): SUS-11-024, SUS-12-005
- α_T jets+Met with ≥0-3 b-jets: SUS−11−022 (7 TeV), SUS-12-016 (8 TeV)
- M_{T2} with b-jets (7 TeV): SUS-12-002
- b-jets+Met (7 TeV): SUS-12-003